SCIENCE ABSTRACTS.

Section A.—PHYSICS.

MARCH 1910.

GENERAL PHYSICS.

298. *New Sclerometer.* **A. L. Parsons.** (Amer. Journ. Sci. 29. pp. 162–167, Feb., 1910.)—The specimen is held with its face just touching a diamond point which is itself supported on a spring. The distance the specimen has to be wound up an inclined plane until the point just makes a scratch on the horizontal surface is measured and gives the pressure of the spring. The apparatus has not yet been tried on minerals, but only on polished faces of glass and metal. Some results are given. L. H. W.

299. *Absolute Measurement of High Pressures.* **P. P. Koch and E. Wagner.** (Ann. d. Physik, 31. 1. pp. 31–50, Dec. 30, 1909.)—Examination of an Amagat manometer, previously employed [see Abstracts Nos. 499 (1905) and 85 (1909)], by direct comparison with a mercury column. A weighing method was also used, but is not quite so accurate. The instrument was sensitive to about ± 0·004 atmo. (up to 30 atmos.) corresponding to an accuracy of adjustment of the reduced mercury column to ± 0·05 mm. of mercury. G. E. A.

300. *Correction of the Specific Gravity of Liquids for the Buoyancy of Air.* **J. Wade and R. W. Merriman.** (Chem. Soc., Journ. 95. pp. 2174–2181, Dec., 1909.)—The ordinary formula for correcting the specific gravity of a liquid for the buoyancy of the air is $S_{t^\circ/t^\circ} = w(1 + 0{\cdot}0012/\rho - 0{\cdot}0012)/W$, where w and W are the apparent weights of liquid and water, S_{t°/t° the corrected sp. gr. of the liquid at t°/t° and ρ its true density at t°(= sp. gr. at $t^\circ/4^\circ$). This value may, however, give inaccurate results, as it assumes a mean value of 0·0012 for σ, the density of the air, and is hence only valid when the pyknometer (or plummet), water and liquid are weighed on a day when the density of the air has the value 0·0012. This condition is only rarely complied with, and from a table of values of σ under different conditions given by the authors, it is seen that these values may, under ordinary conditions, vary by nearly 12 per cent. The full expression for the corrected sp. gr. of a liquid at t°/t°, whether determined by pyknometer or areometer, is given by the following formula, in which w, W are the apparent weights of liquid and water at t°, D the apparent sp. gr. of the liquid at t°/t° ($=w/\mathrm{W}$), B the density of the weights, and σ, σ' the densities of the air at the time of weighing the liquid and water respectively—

$$\begin{aligned} \mathrm{S}_{t^\circ/t^\circ} &= w[1+\sigma(1/\mathrm{D}-1/\mathrm{B})]/\mathrm{W}[1+\sigma'(1-1/\mathrm{B})] \\ &= \mathrm{D}[1+\sigma(1/\mathrm{D}-1/\mathrm{B})]/[1+\sigma'(1-1/\mathrm{B})]. \end{aligned}$$

This formula involves the following assumptions: (1) that variations in the apparent weight of the empty pyknometer are eliminated or allowed for; (2) that in calculating the weight of air displaced by the various masses, the following differences are negligible: (*a*) the differences between the apparent and true weights of the various masses; (*b*) the difference between the apparent sp. gr. of the liquid (D) at t°/t° and its true density (ρ) at $t^\circ/4^\circ$; and (*c*) the temperature variations in the density of the water. For (*a*) the max. resultant error is ± 0·06 per 100,000; for (*b*) ± 0·08 per 100,000, and for (*c*) at 25°, + 0·85; at 20°, + 0·22 and at 15°, + 0·11 per 100,000. As the temperature cannot, as a rule, be regulated more closely than 0·01°, errors of less than 1 per 100,000 may, however, be neglected. Various simplified forms of the above expression are given. T. H. P.

301. *Impact Tests at Variable Temperatures.* **L. Guillet** and **L. Révillon.** (Engineering, 88. pp. 441–442, Oct. 1, 1909. Abstract of paper read before the Internat. Assoc. for Testing Materials, Copenhagen, 1909.)—Reference is first made to the work of Charpy, who found that resilience, *i.e.*, the specific work done in fracture—first increased as the temperature rose to 150° C. and decreased afterwards, reaching a minimum between 400° and 500°. Tests have been carried out with a view to investigating blue-heat brittleness, on carbon steels of increasing carbon content, nickel steels and one nickel-chrome steel. The specimens were broken in a Guillery machine on an anvil with a 1·57-in. opening, and with an initial energy of 484 ft.-lbs. The results showed that the resistance to shock increased up to a temperature of 200° C. when it fell gradually, to increase again when the steel was red-hot. The temperature of max. fragility was always the same and equal to 475° C., a red-glow temperature. This is not the so-called blue heat, 300–325° C. There was a max. resilience, less fixed, at 150°–200° C., depending on the nature of the steel; at this temperature all the specimens showed a strength of at least 72 ft.-lbs. For one of the most brittle steels 36 ft.-lbs. was obtained in the cold, and 72 ft.-lbs. at 200° C. The minimum resilience observed at 475° C. was below the value observed at ordinary temperatures; the difference amounted to 43–50 ft.-lbs., and this decrease was the greater the softer the steel. For nickel steels the figures were 180 ft.-lbs. at ordinary temperature, and 87 at 475° C. Nickel-chrome steel showed a marked constancy: 115 ft.-lbs. in the cold, and the same at the minimum, and the curve ascended very slowly beyond the minimum. The results do not account for the fact that a soft-steel sheet can be broken at a blue heat. C. O. B.

302. *Elastic and Mechanical Theories of Impact.* **C. Ramsauer.** (Ann. d. Physik, 30. 3. pp. 417–494, Nov. 4, 1909. Habilitationsschrift, Heidelberg.) —Previous experimental work shows that the course of an impact is not exactly that required by the elastic solid theory. The present work deals

with the determination of impact velocity and duration of impact, employing a new optical method which allows the course of the impact to be followed independently of all theory. The impinging bodies used were of cylindrical form, and the impact at one end was communicated by means of a lever to a movable mirror at the other end, thus causing the deflection of a spot of light on a rotating drum. The paper is divided into two parts, in each of which one of the theories is tested in the light of experiment. The fundamental condition of the elastic theory, that the impact pressure instantaneously becomes uniform over the section, can be fully realised in practice by the use of spirals and of rubber cylinders with ivory ends. Cylinders of this kind, of the same section and material, fulfil all the demands of the elastic theory as regards the course of the impact, duration of impact and final velocity. The same holds for more complicated cases. Peculiarities noted during impact are due to the dependence of wave velocity on the amplitude of compression, on imperfect elasticity and on elastic after-effect. For small compressions, the wave velocity in rubber reaches a limiting value which lies far above that found by statical methods; from this value the modulus of elasticity can be calculated free from the disturbance due to elastic after-effect. An ideal mechanical impact may be produced by the use of spring heads on solid steel cylinders. This ideal case, besides conforming to the law of conservation of energy, must also be such that the time of impact of equally long cylinders varies as the square root of the length or mass; the time of impact must also be independent of the velocity. The course of the mechanical impact is fundamentally of an elastic nature. If the ratio of the elastic modulus of the rigid portion to the modulus of the head falls from infinity to smaller values, the properties of the impact lie between the two theories; this is the case with the impact of two solid cylinders, which proceeds as though the transference of energy took place by means of a more easily compressible intervening layer. G. E. A.

303. *Tests of Copper Wire.* **F. Schüle** and **E. Brunner.** (Engineering, 88. p. 438; Discussion, p. 438, Oct. 1, 1909. Abstract of paper read before the Internat. Assoc. for Testing Materials, Copenhagen, 1909.)—The original paper contains complete tables giving results of tensile, torsion and impact bending tests. Endurance-bending tests, carried out in a special machine, in which the wires are bent to and fro until fracture occurred are given. The wires used were trolley-wires which in practice undergo, near their suspension points, local bending stresses which are very injurious to their durability; they also have to withstand tensile stresses due to sagging and temperature-variations. It is found that only hard copper can withstand to-and-fro bendings repeated over millions of times to a radius of 18 ft. under a tension of 2845 lbs. per sq. in. C. O. B.

304. *Tests of Cast Iron.* **E. Adamson.** (Iron and Steel Inst., Journ. 80. pp. 208–220; Discussion, pp. 221–222, 1909. Abstracts in Engineering, 88. pp. 529–531, Oct. 15, 1909. Mech. Eng. 24. pp. 486–489, Oct. 15, 1909.)—The author's tests lead him to the following conclusions: (1) The best tensile and transverse tests are obtained from bars which have been machined. (2) Transverse test-bars cast on edge and tested with the "fin" in compression give the best results in testing. (3) The transverse test is not so reliable or helpful as that of the moment of resistance. (4) The use of high-grade ferro-silicon in the foundry is of no commercial value. (5) Cast iron gives the best results when poured as hot as possible. L. H. W.

305. *New Experimental Method of Investigating Certain Systems of Stress.* **G. H. Gulliver.** (Roy. Soc. Edinburgh, Proc. 30. pp. 38–45, 1909–1910.)—When a bar of metal is permanently strained, deformation occurs mainly by slips along surfaces within the metal, and these surfaces leave traces on the external face of the bar, known as Lüder's lines. These surfaces are inclined at about 50° to the max. principal tension or minimum compression, and at about 40° to the max. principal compression or minimum tension, and are parallel to the intermediate principal stress. Within certain limits, the general scheme of stress direction can be constructed geometrically after a network of Lüder's lines has been well developed, but since deformation must occur before the lines appear, there is some distortion of the original stress. The determination of a system of stress appears to be closely connected with that of hydrodynamic flow under corresponding conditions. Comparison of the stream-line diagrams of a fluid obtained in Hele-Shaw's apparatus (see Brit. Assoc. Report, 1898), with the stress-line diagrams of a solid, shows that under identical boundary conditions the two systems agree very closely. There are some anomalies in the character of the lines of deformation, traceable to the existence of secondary stresses varying with the shape of the bar. F. C. A. H. L.

306. *Soldered Joints in Copper Tubes.* **M. Rudeloff.** (Königl. Material-prüfungsamt, Mitt. 27. 5 and 6. pp. 317–338, 1909.)—A large number of tests on the mechanical properties of soldered copper joints have been made with a view to determining the effect of the various processes involved, on the strength of the joint and of the copper itself. The effect of rolling the sheet into tubes is to increase the limit of elasticity and decrease the elongation, but this effect is practically removed by the heating during soldering. By drawing the tube after the joint has been made, the mechanical properties are improved, this effect being particularly noticeable in tubes made from thin sheets. Annealing completely removes the increase in elastic limits. Thick-walled tubes show a greater tendency to break at the joint than thin tubes. Tests made at elevated temperatures show that there is very little effect on the elastic limit of the annealed unsoldered materials up to 400°C. The elastic limit of the unannealed specimens and the tenacity of all the samples, decrease with increase of temperature. A decrease of elongation is specially noticeable between 200° and 300° C. Drawing the tube subsequent to the soldering appears to favourably influence the strength of the joint, and the effect of cold-working appears to persist at higher temperatures. The difficulty of obtaining joints free from blow-holes appears to increase with the amount of overlapping. On the whole, the results prove that a tube with a well-soldered joint is practically as strong at high temperatures as a tube without a joint, and is therefore equally capable of withstanding internal pressure.

F. C. A. H. L.

307. *Propagation of Shearing Deformations in Liquids.* **R. Reiger.** (Ann. d. Physik, 31. 1. pp. 51–92, Dec. 30, 1909.)—The author discusses the classical and relaxation theories of viscosity, and describes a number of experiments which show that, for the periods of vibration employed by him, shearing deformations are propagated in liquids like olive oil and water according to the laws of the classical theory. From this it follows that viscosity coefficients may be measured by two new methods: (1) from a determination of the absorption coefficient, and (2) by determining the velocity of propagation of shearing deformations. If the disturbance proceeds from a finite region, the velocity of propagation and the absorption are found to be too high according to theory. The smaller the region of disturbance, that is, the greater the deviation from a plane wave, the greater will be the velocity of propagation and the extent to which the wave is absorbed. Of the two fundamental equations $2\eta/\rho = v/\beta$ and $2\pi/\tau = v\beta$ (where $\eta = NT$, the coefficient of viscosity, ρ the density, v the velocity of propagation, β the absorption coefficient, and τ the period of vibration), the first is always fulfilled even when the region of disturbance has finite limits, whilst the second holds only for plane waves, in which case the dispersion-curves for v and β, if the frequency $n = 1/\tau$ is introduced, are parabolas. The fact that Coulomb's method gives high values for the viscosity coefficient is explained by the circumstance that the log. decrement is proportional as a first approximation to the length of the emitted wave. For liquids with low viscosities and small relaxation-times, the relaxation theory is of mainly theoretical interest, but it may attain practical importance for viscous substances, especially viscous magmas, and is, hence, of interest in the study of earthquakes. T. H. P.

308. *Air-resistance in the Light of Recent Experiments.* **W. Schüle.** (Zeitschr. Vereines Deutsch. Ing. **54.** pp. 12–18, Jan. 1; 54–59, Jan. 8, and pp. 94–101, Jan. 15, 1910.)—A useful critical comparison of the work of Frank [Abstracts Nos. 926 (1905), 1008 (1906), 17 (1909)] and Eiffel [Abstract No. 706 (1908)]. The law that resistance is proportional to the square of the velocity has been verified by Frank for velocities up to 6 m./sec., and by Eiffel from 15 to 40 m./sec. The specific resistance is proportional to the normal area, and this resistance does not reach its maximum with an area of 1 sq. m. (Eiffel). The results of Frank for right circular cylinders and cones of various angles are in contradiction to those of Eiffel. The error is considered to be on the side of Eiffel; and further, the resistances deduced by the latter from his experiments with inclined plates require substantial correction. The resistance of an inclined plate increases very quickly with the inclination of the plate up to 30°, and much more slowly thereafter. Frank's coefficient for the surface friction of plates moving parallel to their length, viz., 0·00244, shows that the resistance of such a plate is 286 times less than that for the same plate moving along the normal. This coefficient agrees well with the resistance coefficient of vapours and gases in motion through tubes. In the region from 10° to 0° plate inclination, the surface friction is of prime influence on the specific resistance. Employing Frank's law of friction along with Eiffel's results for plates inclined at 20° to 80°, the air-resistance may be found for the region of most importance in flying technique, viz., between 0° and 15°; at 5° inclination, the resistance R, referred to the unit of surface projection, passes through a minimum value (k min. $= 0{\cdot}1$ in the formula $R = k \times \text{area} \times \text{air density} \times \text{velocity}^2/g$). Air-resistance is composed of three parts—the acceleration resistance, and friction, external and internal. External friction only becomes of importance for angles of 15° inclination and less. The direction of the resultant thrust on a plane surface only begins to deviate from the normal for plate inclinations of 5° and less; for 5° the deviation is 4° from the normal, and for 1° it is 24°. The ratio of upthrust to moving force for an inclined plate in motion is greatest for an inclination of 5°, and the absolute upthrust reaches a maximum for the angle of 32°. G. E. A.

309. *Principles of Dynamics.* **N. Campbell.** (Phil. Mag. **19.** pp. 168–181, Jan., 1910.)—In dealing with physical problems we are concerned with three distinct classes of concepts. Firstly, we have purely physical concepts, such as length, time, pressure. These are not capable of mathematical relation to one another. To apply mathematics to physical problems we have to define fresh concepts which may be denoted by Length, Time, Pressure. These are mathematical concepts directly connected with the physical ones by a relation which may be called A. In order to establish relation A assumptions are requisite, and the number and nature of these have to be arrived at in the first place intuitively by a process of guided guessing; while their validity is ultimately determined by the agreement with each other, and with earlier assumptions. A third class of concepts, also mathematical, are not capable of correlation by relation A with any purely physical concepts, but can only be so correlated through the equations of theoretical dynamics, as, for example, Absolute Co-ordinates, Absolute Accelerations, Partial Accelerations. We may apply these considerations to such a question as, "Is motion absolute or relative?" In this form the question has no meaning, for "motion" is not a mathematical quantity. To the question, "Is Motion Absolute or Relative?" the reply would be that both are valid concepts, but the former is less fundamental and necessary to the physical student, in that it cannot be related in so simple a way as the latter to the results of observation. Relative Motion can be connected with a physical concept by relation A, Absolute Motion only through the equations of theoretical dynamics. For theoretical dynamics, on the other hand, Absolute Motion is the more fundamental concept. As a further example take the statement: "While no experiment can detect a Uniform Absolute Velocity of the whole of a dynamical system, yet experiment can detect a Uniform Absolute Rotation of such a system. This is equivalent to the following: If in the equations of dynamics we substitute for the Absolute Co-ordinates x_m, y_m, z_m, &c., other quantities, x'_m, y'_m, z'_m, &c., defined by—

$$x'_m = x_m + a_x t + b_x,\ y'_m = y_m + a_y t + b_y, \text{ \&c.},$$

$a_x, \dots b_x$, &c., being constants, then the values of r_{mn}, &c., obtained by solving the equations are unaltered. But if we substitute for the Absolute Co-ordinates quantities defined by—

$$x'_m dy'_m/dt - y'_m dx'_m/dt = x_m dy_m/dt = y_m dx_m/dt + a_m, \text{ \&c.},$$

then we shall obtain different values for r_{mn}. G. W. DE T.

310. *The Æther.* **N. Campbell.** (Phil. Mag. 19. pp. 181–191, Jan., 1910.)—The concept of the æther was developed in order to provide a vehicle for the undulatory energy of light, and is now regarded as the vehicle of all forms of electromagnetic energy. It would, therefore, appear natural to identify points in the æther by the amounts of energy located in them. But consider the case of two or more electrically charged bodies moving with different uniform velocities relative to the observer. The velocity of the æther relative to the observer would then be different according as one or other of the charged bodies was considered, and would be, in each case, the same as the velocity of the corresponding charged body relative to the observer. This leads directly to the principle of relativity, which has been proved to form an adequate basis for electromagnetic theory. If it be not permitted so to identify a point in the æther, no other means of identification can be substituted. The first requisite for the application to the æther of the definition of velocity, which is implied in all statements concerning the velocities of material bodies, cannot therefore be fulfilled; until some other definition of velocity is put forward as applicable to the æther, all propositions about velocity of or relative to the æther are meaningless. This objection would be removed if it were possible to define the velocity of a charged body relative to the æther as its "Absolute Velocity" [see preceding Abstract]. But Absolute Velocity is meaningless unless the fundamental propositions of dynamics are assumed to be true. It is therefore logically impossible to assert at the same time (1) that axes fixed in the æther are axes of which the Absolute Velocity is nil, and (2) that the Mass of a body increases with its Velocity relative to those axes. It is therefore contended that the concept of the æther should be abandoned, and electromagnetic theory embodied in equations based on the principle of relativity. G. W. DE T.

311. *Number of Free Corpuscles per Unit Volume in Gold, Silver, and Platinum.* **B. J. Spence.** (Phys. Rev. 28. pp. 337–348, May, 1909.)—Several writers have attempted to establish upper and lower limits to the number of free corpuscles per unit volume of the metals, but conflicting results appear, depending upon the manner in which the values have been obtained. In his "Corpuscular Theory of Matter," J. J. Thomson describes several methods for finding limiting values. One of these, based upon the work of Rubens and Hagen, on the reflection of longer heat-rays from metals, leads to a lower limit. By this method Thomson derives $1{\cdot}8 \times 10^{24}$ as the number of free corpuscles per cm.^{3} for silver. But this value led to a difficulty, for Thomson then showed that [on a certain hypothesis] the kinetic theory of gases would give as the energy necessary to warm 1 cm.^{3} of silver 1° C., a value exceeding $2{\cdot}7 \times 10^8$ ergs, or about 6 gm.-calories, whereas it is known that the energy necessary to raise the temperature 1° C. of both atoms and corpuscles is only 0·6 calorie for 1 cm.^{3} of silver. Schuster used a method based on principles similar to those of Drude, upon which also the present author's method is based. The conclusions then reached are briefly as follows; (1) The effect of the vibrating corpuscle in the visible spectrum of Au, Ag, and Pt has very little effect upon the optical properties of these metals after we arrive at a wave-length, which for Ag and Au is beyond $1\,\mu$, and for Pt $1{\cdot}8\,\mu$. (2) The value of N obtained is of the order 10^{23} for Ag and Au, and under 10^{23} for Pt. The specific values for Ag, Au, and Pt are respectively 0·37, 0·38, and *less than* 0·31, each multiplied by 10^{23}. The belief that they are correct is based upon the values of the conductivities to which they lead. [See also Abstract No. 96 (1908).] E. H. B.

312. *Molecular Diameters.* **W. Sutherland.** (Phil. Mag. 19. pp. 25–26, Jan., 1910.)—Already improvements in the fundamental data make it necessary to revise the list of molecular diameters given in 1909 [see Abstract No. 374 (1909)]. That list was derived from one calculated by Jeans, who took for N, the number of molecules per cm.^{3} of gas under standard conditions, the value 4×10^{19}, which was the best then obtainable. The present author further refined matters by allowing for the effects of cohesional force. But now from the study of the α-particle Rutherford finds $N = 2{\cdot}77 \times 10^{19}$, in close agreement with $2{\cdot}80 \times 10^{19}$ found by Planck from the thermodynamics of radiation. The recalculation of molecular diameters is, however, very simple, because the best source of values is data like that used for air by Jeans from its viscosity, namely, $N\sigma^2 = 3806$ cm.^{2}, where σ is the diam. of a molecule of

air. On applying the necessary correction for the new value of N, and retaining the cohesional force, the following list is found of 10^8 times the molecular diameters in cm. :—

H_2	He	CO	C_2H_4	N_2	Air	NO	O_2	A	CO_2	N_2O	Cl_2
2·17	1·92	2·74	3·31	2·95	2·86	2·59	2·71	2·66	2·90	3·33	3·76

E. H. B.

313. *Observations of Dew at Kimberley.* **J. R. Sutton.** (Roy. Dublin Soc., Proc. 12. 24. pp. 266–274, Jan., 1910.)—The formation of dew is by no means confined to occasions at clear sky or little cloud. When the sky is overcast the air generally contains more moisture than when it is clear, and hence a smaller fall of temperature suffices for the formation of dew. Observations were made at 8 p.m., 11 p.m., and 8 a.m.; on 258 occasions dew was observed with clear sky, on 85 occasions with slight cloud, and on 177 occasions of much cloud. Dew was observed at 11 p.m. on 56 occasions of completely overcast sky both at 8 p.m. and 11 p.m., and on only 54 occasions of clear sky at both these hours. If there is much moisture in the air the rate of fall of temperature is greatly checked even if there is no cloud. Taking nights of relative humidity over 90 per cent., the average fall of temperature from midnight to the following minimum is 4·9° for clear nights, and 4·3° for very cloudy nights. R. G. K. L.

314. *Temperature Inversions at the Mount Weather Observatory.* **A. J. Henry.** (Mount Weather Observatory, Bull. 1. 2. pp. 148–160, 1908.)—Inversions are defined as regions in which the vertical temperature gradient of the free atmosphere is positive. They were met with on 61 per cent. of the 236 days on which kite flights were made from Mount Weather Observatory (526 m.) during the 9 months July, 1907, to March, 1908. 25 per cent. of these cases occurred in the air stratum from 200 m. to 500 m. aboveground, 28 per cent. in that from 500 m. to 1000 m. Special interest attaches to inversions found in front of a depression advancing from the westward. Several cases are described in which warm south-westerly winds were found under these circumstances flowing over decidedly colder south-easterly winds. R. G. K. L.

315. *Dimensions of the Earth's Nucleus.* **W. Krebs.** (Phys. Zeitschr. 10. p. 1024, Dec. 15, 1909.)—The periods of 33, 60, and 24 minutes found in seismograms are discussed. Oddone considers 33 and 60 min. to be the times taken by the first and second phase waves to travel to the antipodes and back, *i.e.*, a distance of two terrestrial diameters. The author regards the 24 min. as the time taken by the preliminary tremors to travel through the earth's nucleus to its antipodal boundary and to return after reflection there. He thus obtains 9850 or 10,026 km. as the diam. of the nucleus according as he adopts Wiechert's or Benndorf's value for the velocity of propagation in the nucleus relative to that in the crust. A. D. R.

316. *Seismic Radiations.* **C. G. Knott.** (Roy. Soc. Edinburgh, Proc. 30. pp. 23–37, 1909–1910.)—In a former paper [Abstract No. 721 (1908)] an endeavour was made to find a simple distribution of density and elasticity in terms of which the transmission of seismic disturbances could be described; in this it was concluded that the observed facts of seismic radiation can be co-ordinated on the assumption that throughout all but a comparatively thin

crust of the earth the elastic waves of highest speed are transmitted with a speed of 12·28 km. per sec., and that within this crust, of thickness equal to one-tenth the radius, the speed diminishes from 12·28 km. per sec. at the inner surface to 6 km. per sec. at the outer surface. The present paper deals with the value of the real angle of emergence as compared with the angle of incidence of the radiation impinging internally on the surface, keeping the discussion to the case of an elastic solid, like rock of density about 3, with its plane surface in contact with air, or, what is practically the same thing, vacuum. It is evident there is a reflected distortional wave as well as a reflected longitudinal wave. The analysis of these is considered in detail, with the conclusion that when a plane condensational sinusoidal wave falls on the plane boundary of the elastic solid through which it is travelling, every point of the surface is thrown into a rectilinear sinusoidal motion, whose direction, for most instances, makes, with the direction of the displacement in the incident ray, an angle not exceeding 4·5°, and generally much less. In the case of earthquake waves, the angles of incidence becomes less than 30° at a comparatively short arcual distance from the source of the disturbance. The vertical displacement is therefore greater than the horizontal displacement, so that a horizontal pendulum assumed to record only horizontal movements will respond to a small fraction of the whole. Dealing with the distortional wave incident in the rock, it is found that there are two reflected waves of different type sent back into the medium, and the associated displacement of each point of the surface is a rectilinear sinusoidal motion. In the distortional wave the displacement is at right angles to the direction of propagation of the waves. The normal displacement rapidly diminishes to zero as the critical angle is approached, while at the same time the tangential displacement grows steadily. Reference is made to a paper by Wiechert and Zoeppritz [Abstract No. 1048 (1908)], worked out on similar lines. They find that the elastic waves of highest speed are transmitted through a core of radius equal to three-quarters of the earth's radius with a speed of 12·9 km. per sec., and through the remaining layer of thickness equal to one-quarter the earth's radius with a speed which falls off from the value at the inner surface to 7·17 km. per sec. at the outer surface. C. P. B.

317. *Determination of Azimuth of Seismic Radiations.* **A. Pécsi.** (Journ. de Physique, 9. pp. 50–54, Jan., 1910.)—The author discusses the determination of the azimuth from the amplitude of the two horizontal components of the vibration as given by various types of seismograph. Pendulums of the Vicentini type are shown to be very simple and reliable for this work. The elasticity of the supporting wire, the friction of the recording styles, and the action of the damping apparatus, do not produce appreciable error in the calculated azimuth. When pendulums of the Milne or Kilian types are employed two instruments are necessary, and there is trouble in getting them of the same sensitiveness. They have, however, an advantage in giving completely separate records of the two components. Inverted pendulums of the Wiechert type are less satisfactory for the purpose. The sensitiveness for the two components is usually different, and is liable to vary from time to time. A. D. R.

318. *Solar Outburst and Magnetic Storm.* **C. M. Smith.** (Roy. Astronom. Soc., M.N. 70. pp. 23–24, Nov., 1909.)—On the forenoon of Sept. 28 the region of the large spot group presented such appearances during spectroscopic examination that it was evident a large prominence was overlying the

spot, and the form of the region showing the reversed line was apparently quickly changing. On developing the magnetograph sheets for the day, it was found that a very sudden rise had taken place in the horizontal force at or near the time of the solar eruption. C. P. B.

319. *Origin of Chromospheric Light.* **W. H. Julius.** (Konink. Akad. Wetensch. Amsterdam, Proc. 12. pp. 446–452, Dec. 23, 1909.)—In a recently published paper [Abstract No. 24 (1910)] Hale and Adams have stated that the chromospheric lines coincide very closely in position with the Fraunhofer lines, and that this precluded the acceptance of Julius' hypothesis to account for the chromospheric phenomena as due to anomalous dispersion [Abstract No. 88 (1901)]. Julius points out that the width of the wave-length region in which a certain line of the solar spectrum produces appreciable anomalous dispersion, depends on the concentration with which the corresponding vibrating system is represented in the parts of the solar atmosphere traversed by the beam under consideration. With most lines that region is narrow, as in the case of most of the Fraunhofer lines. The anomalous refraction theory requires the centre of gravity of chromospheric lines to be included within these limited regions, and this would indicate an agreement of chromospheric with Fraunhofer wave-lengths to about the amount stated, ± 0·018 Å. C. P. B.

320. *Hydrogen Flocculi Structure.* **G. E. Hale** and **F. Ellerman.** (Roy. Soc., Proc. Ser. A. 83. pp. 177–189, Jan. 7, 1910.)—Dealing with the various opinions put forward to explain the peculiar appearances of dark hydrogen flocculi, the authors consider that there is abundant evidence that the phenomenon is not due to absence of hydrogen, and is more probably caused by increased absorption in consequence of an extra quantity of the gas located at certain places. Photographs of the spectrum of these regions show that the hydrogen lines are certainly both strengthened and widened. Further, the criticism that the effects are due to a fundamental defect of the spectroheliograph by its being unable to record the whole of the phenomena corresponding to a line of unequal width, also appears to be illusory, as the absorption view would equally apply to explain the varying widths of the hydrogen line. The photograph resulting from the passage of the slit through the central core would then represent one state of hydrogen absorption, and that when the slit only passed through the excrescences of the line would represent another state of hydrogen, probably at a different level. All of these phenomena are most marked in active regions of the sun, but in localities far removed from spots and eruptions the H_α line also shows distinct differences in intensity and width. It has been found that the central part of H_α gives the bright flocculi, which are not recorded when the camera slit is set on the wings, and that dark flocculi, showing vortex structure, can also be photographed when no light from the wings enters the camera slit. Deslandres and d'Azambuja pointed out that the dark flocculi photographed with a very narrow slit at the centre of H_α differ decidedly in form and appearance from those obtained with the light of the wings. On comparing spectroheliograms taken with different hydrogen lines, H_δ, H_γ, H_β, and H_α, evidence is found of a progressive variation of level, that of H_α being highest. Similar comparisons with calcium H_2 indicate that the H^δ flocculi are, in general, higher than the calcium clouds. The question as to the probability of the phenomena being due to anomalous dispersion through the varying density gradients of the solar atmosphere is also discussed. Test photo-

graphs were specially taken with powerful dispersion, using the red and violet sides of the H_a line, which ought to show different character images if anomalous dispersion had any appreciable effect. On examining these images with the stereo-comparator, it is found that in general the two images are almost identical in their principal features, though small differences in detail are often visible. In the case of eruptive phenomena the images are often unlike, as the distortion of the H_a line would lead us to expect.

C. P. B.

321. *Ultimate Lines in the Solar Spectrum and Stellar Spectra.* **A. de Gramont.** (Comptes Rendus, 150. pp. 37–40, Jan. 3, and pp. 154–156, Jan. 17, 1910.)—The author designates as ultimate lines the remnant of the lines of a spectrum most persistent through the different conditions given by varying sources of vaporisation, electric arc and spark, oxyhydrogen flame, &c. A list of these is given for the more important elements present in the sun, with an indication of the height to which they have been recognised in the chromosphere. In the second article the author deals with the mode of occurrence of these ultimate lines in stellar spectra, the latter being taken from various sources, including Harvard College Observatory Annals, Kensington stellar classification, Huggins' atlas of stellar spectra. The scheme of classification adopted is that of the Draper Catalogues. It is found that the ultimate rays make their appearance in Algol (B8A), which is the connecting type with the hydrogen stars (group A), such as Sirius and Castor: They are shown in group K, represented by Arcturus, where the ultra-violet region commences to be enfeebled, and which may be regarded as connecting with the type of banded spectra represented by Betelgeuse (M_b). A table is given of the ultimate lines under discussion, with their relative intensities in the various stellar groups.

C. P. B.

322. *Magnetic Storm and Associated Solar Phenomena.* **H. Deslandres.** (Comptes Rendus, 150. pp. 65–72, Jan. 10, 1910.)—In discussing the phenomena accompanying the great magnetic storm of Sept. 25, 1909, attention is directed to the difficulties in ascribing a direct connection between magnetic storms and the spots which may have been in evidence on the sun at the time. Numerous cases are on record when a large spot has passed the central solar meridian without any associated magnetic disturbance. At Meudon a large number of photographs were obtained with spectroheliographs of varying powers, showing the forms of the atmospheric vapours at different levels. Two large filaments were present on Sept. 23 and 24, but had nearly disappeared by the 25th. This definite modification of structure is suggestive that the filamentous structure may be more directly connected with the magnetic disturbance than the spot eruption itself. Round the spot there are indications of vortical filaments. On careful examination of the K_3 image the surface is seen to be covered with polygonal cell formations somewhat analogous to those known to occur in liquid vortices. Further discussion is given as to the influence of possible kathode rays deflected by the solar magnetic field, to explain the magnetic lag of 45 hours.

C. P. B.

323. *Binary Progression of Planetary Distances.* **H. Wilde.** (Manchester Lit. and Phil. Soc., Mem. 54. 1. pp. 1–11, 1909–1910.)—In a previous paper [Abstract No. 1888 (1909)] it was demonstrated that the moving force of celestial bodies is as the square of the velocity, in accordance with the experimental results obtained with moving bodies at the earth's surface. The moving force is to be regarded as distinct from the static attraction of gravitation (although correlated with it), as dynamic electricity is from the static force of magnetism. As the moving and attractive forces of planetary bodies are correlatively equal, and are expressed by the same numbers, the radius vector of Mercury is taken as the most convenient unit to which the other planetary distances are referred. In this case the new equivalent of Bode's Law may be stated thus:—

Planets	Mercury	Venus	Earth	Mars	Ceres	Jupiter	Saturn	Uranus	Neptune
Binary Progression	0·00	0·75	1·50	3	6	12	24	48	96
Distances	1·00	1·75	2·50	4	7	13	25	49	97

The differences between these indicated values and the observed distances are ascribed to interplanetary perturbation, and are indicated in an extended table showing the difference from the older law of Bode. The anomalous departure of the distance of Neptune is still very apparent. It is suggested that this is caused by the combined attraction of the sun and interior planets contracting the Neptunean orbit, and may be a strong indication of the non-existence of another planet beyond Neptune. C. P. B.

324. *Jupiter Markings.* **H. E. Lau, C. Luplau-Jannsen.** (Astronom. Nachr. No. 4372. Nature, 82. p. 202, Dec. 16, 1909. Abstract.)—Observations during Jan.–May, 1909, indicate that during that period the activity of the southern regions was considerably greater than that of the northern area. In April a band projecting from the southern edge of band V was noted. **S. Bolton.** (Nature, 82. p. 128, Dec. 2, 1909.)—Transit estimates of the red spot hollow on Jupiter, obtained between 1908, Dec. 20, and 1909, June 12, indicate that there was an average monthly increase of 1·03° in longitude, but the motion was not constant. The mean rotation period of the hollow appears thus to have been 9h. 55m. 42·0s. C. P. B.

325. *Physical Features of Mars.* **E. M. Antoniadi, M. Jonckheere.** (Astronom. Nachr., Nos. 4358, 4363, and 4376. Nature, 82. pp. 227–228, Dec. 23, 1909. Abstract.)—Discussion of the reality or otherwise of a dark band which has been described as surrounding the polar cap. If real, it should appear broader at the two extremities of the elliptical band; but the drawings show it as being about the same width throughout its extent. C. P. B.

326. *Markings on Mars.* **P. Lowell.** (Nature, 82. pp. 397–398, Feb. 3, 1910.)—In regard to the recently expressed opinion that certain telescopes are too powerful to show the minute detail on Mars, the author replies that in certain cases large telescopes are liable to less accurate definition. The spurious disc and rings made of a star by a telescope is a real image, due to the interference of the light-waves. If atmosphere and glass be perfect, this image consists of a round disc, encircled by concentric and continuous rings of light. The only difference in the image with different apertures is that the larger the aperture the smaller the disc, and the closer and thinner the rings. If this image assume any other form, it is either because the objective is poor, or because the seeing is defective. In proportion as the seeing is bad, the rings begin to waver, then break up into fragments, and finally end in an indiscriminate assemblage of points. With a certain amount of this unsteadiness it is found that by stopping down the aperture of the objective a point is reached where the definition is best. This same criterion will also apply to the delineation of fine detail on a planetary disc, and a series of linear markings would, under such conditions, break up into a mosaic, contrary to their true form of continuous linearity. C. P. B.

327. *Comet Photography.* **H. Deslandres.** (Comptes Rendus, 149. pp. 1101–1103, Dec. 13, 1909.)—The great reflector at Meudon (aperture 1 m., focal length 3 m.) has hitherto only been applicable to the photography of fixed stars, nebulæ, &c., and arrangements have therefore been made to provide the necessary accessories for the photography of moving objects such as comets, &c. The chief of these is a visual guiding telescope of 0·15 m. aperture and 2·30 m. focal length, which is fixed to the reflector mounting. With an eyepiece of large field and a rectangular adjustment in two directions mutually perpendicular to the telescope axis, means is afforded of following on any star in the neighbourhood of a comet or on the comet itself. The first application of the arrangement has been in the photography of Halley's comet. [See next Abstract.] C. P. B.

328. *Spectrum of Halley's Comet.* **H. Deslandres** and **A. Bernard.** (Comptes Rendus, 149. pp. 1103–1105, Dec. 13, 1909.)—The spectrum of Comet Halley has been photographed at Meudon with a small objective prism spectrograph attached to the Eicheus Equatorial. The prism has an angle of 22°; the objective is 0·10 m. aperture and 0·30 m. focal length. Carried on the same mounting is a photographic camera and a visual guiding telescope. Successful plates were obtained on Dec. 6 and 8, with exposures of 2 and 3 hours respectively. In spite of the feebleness of the dispersion, the spectra are seen to be sharply discontinuous. Two of the violet bands appear to be near λ388 and λ3914·5. C. P. B.

329. *Standard Photographic Magnitudes.* **H. L. Leavitt.** (Science, 30. p. 726, Nov. 19, 1909. Paper read before the Astronom. and Astrophys. Soc. of America.)—Observations have been made for determining the absolute photographic magnitudes of a sequence of 47 stars near the North Pole. Sequences of 40 stars in the Pleiades and 26 stars in Præsepe have also been measured, and compared with the polar stars. Three different methods were employed, (*a*) reduction of light by screens, aperture of telescope, or auxiliary prism to the object-glass; (*b*) division of light from the objective by means of two thin plates of Iceland spar; (*c*) extra focal images of star under examination and Pole star on same plate. The results by the various methods are found to be in good agreement in the majority of cases, and also are in good accord with the Harvard photometric scale as far as magnitude 13·2. It must be noted that a considerable error may arise if it be assumed that the atmospheric absorption is the same in different azimuths. C. P. B.

330. *Spectrum of Comet* 1910(*a*). **H. Deslandres, A. Bernard,** and **L. d'Azambuja.** (Comptes Rendus, 150. pp. 253–256, Jan. 31, 1910.)—The comet was under observation from Jan. 21, being visible to the naked eye on Jan. 21 and 22. Photographs of the comet and of its spectrum were obtained on the 22nd, the best plate showing a continuous spectrum from the nucleus extending from λ7000 to λ4200, with several sharp condensations. The brightest condensation was about λ5900, and may be due to sodium. In this same radiation an extension of the tail can be traced for about 20′ of arc. Other bands occur at λ5600, λ4700. On the photographs obtained on subsequent days several important changes were noted. The sodium band gradually diminished, while the hydrocarbon bands were augmented in brilliancy; the continuous spectrum extended to the ultra-violet and the cyanogen band appeared. On Jan. 29 and 30 the sodium band had disappeared, while the hydrocarbon bands (565, 517, 474) and the cyanogen bands (388, 387, 386) were very intense. The hydrocarbon spectrum appeared to extend into the tail for a considerable distance. The ordinary photographs show on the 22nd a beautiful curved tail, having the long antennæ separated by a sharp dark space. On the 29th a supplementary tail was developed, almost as intense as the first, and making an angle of 25° with it on the side towards the south. Observations with a Nicol prism showed that the light from the tail of the comet was very strongly polarised in the plane containing the sun, comet, and earth. C. P. B.

331. *Spectroscopic Determination of Systematic Stellar Motions.* **S. S. Hough** and **J. Halm.** (Roy. Astronom. Soc., M.N. 70. pp. 85–108, Nov. 12, 1909.)—This paper contains a provisional discussion of the radial velocities of 818 stars situated between the 30th northern parallel and the South Pole. The preliminary analysis clearly shows that the radial velocities of the northern as well as the southern stars are not completely represented by an equation based on the relative number of stars in the supposed drifts, and that there is distinct evidence of systematic deviations depending on the positions of the stars in the heavens. The resulting directions of relative motions of the two drifts obtained from radial velocities are in good agreement with the determination of Dyson from the analysis of stellar proper motions. The relative velocity comes out at 52·4 km. It is noted that the relative motion of the two streams is situated in the plane of the galaxy, and directed towards its densest part. C. P. B.

332. *Effective Temperatures of Stars.* **C. Nordmann.** (Comptes Rendus, 149. pp. 1038–1041, Dec. 6, 1909.)—In a previous paper [see Abstract No. 84 (1910)] the author gave an account of his investigation of a series of stellar temperatures, and compared the results with the classifications of other observers, showing a considerable agreement in the general order of temperature-change. By certain subsequent modifications he now gives a different value for his extreme values, which had to be obtained by extrapolation, bringing down his highest temperatures from 100,000° to 40,000° abs. By means of a curve the divergence of the two series is clearly shown. The following values are selected for typical stars :—

ρ Persei............	2870°	δ Cephei (max.)	6900°	β Persei	13,300°
ξ Cephii	4260°	γ Tauri	7250°	γ Lyræ	14,500°
δ Cephei (min.)	4550°	R.X. Herculis	7850°	ε Persei	15,200°
Sun	5320°	Polaris	8200°	δ Persei	18,500°
γ Cygni............	5620°	α Lyræ	12,000°	λ Tauri	40,000°

C. P. B.

333. *Determination of Speed of Light of β Aurigæ in connection with Dispersion in Space.* **A. A. Bélopolsky [Bělopoliskij].** (Acad. Sci. St. Pétersbourg, Bull. 16. pp. 1103–1106, Nov. 15, 1909.)—From a series of 45 spectrograms of β Aurigæ obtained in 1904 the author prepared a table which showed that, at a time shortly after the fusion of the lines—in the spectrum of the star the lines periodically separate—the blue light (λ = 448–455 μμ) gives a less relative speed than the violet light (λ = 398–400 μμ), the mean

difference being 8 ± 0·7 km. From further spectrograms, obtained in 1906, corresponding with a period adjacent to the fusion of the lines, the light-velocities have been measured, and their relation to the wave-lengths shown graphically. The slope ϕ of this curve indicates the existence of a systematic error dependent on λ. But if the values of the slope are considered in relation to the intervals of time elapsing since the fusion of the lines—the period being 3·96 days—the signs of the slopes are found to be divided into four groups: for $\tau = 0·1–0·7$ day and $\tau = 2·2–2·5$ days, the plus sign predominates, showing that in these periods the blue light gives a greater velocity of light than the violet; for $\tau = 1·3–1·7$ days and $\tau = 3·3–3·7$ days, the minus sign predominates, indicating during these periods a greater velocity for the violet light than for the blue. The mean value of ϕ, independently of the sign, is $0·60 \pm 0·09°$. The calculated difference of velocity of the lights having $\lambda = 393·38$ and 486·15 $\mu\mu$ is 6·8 ± 0·8 km., which is of the same order as the value obtained in 1904. T. H. P.

334. *Three Stars with great Radial Velocity.* **H. D. Curtiss.** (Science, 30. p. 782, Nov. 19, 1909. Paper read before the Astronom. and Astrophys. Soc. of America.)—During the progress of the D. O. Mills expedition from the Lick Observatory several cases of great radial motion have been found. The three greatest are: (1) Cordoba 5·243h., magnitude 9·2, exposure of 29 hours on 4 nights. Mean of two plates shows recession of 242 km. per sec. from the sun, giving a space velocity of about 261 km. per sec., directed towards the point $\alpha = 122°$, $\delta = -60°$. (2) Lacaille 2957 has a velocity of recession of 100 km. per sec. (3) Lacaille 8362 a velocity of approach of 132 km. per sec. C. P. B.

335. *Algol System Z Draconis.* **R. S. Dugan.** (Science, 30. p. 726, Nov. 19, 1909. Paper read before the Astronom. and Astrophys. Soc. of America.) —From a series of 18,834 settings with the Pickering sliding prism polarising photometer, attached to the 23-in. equatorial, during a period including 11 minima, a graphical determination of new elements has been made. The star at its minimum phase was only just visible, there being no variability in the depth of minimum under these conditions. The mean curve shows a nearly symmetrical primary minimum consisting of a drop of 2·55 magnitudes, and a secondary minimum of 0·065 magnitude, each lasting about 6 hours. The average surface intensity of one star is 18 times that of the other; the radius of the fainter lies between 0·98 and 1·36 times that of the brighter. The radius of the orbit is from 3·5 to 5 times the radius of the brighter star. C. P. B.

336. *New Variable Star or Nova.* **C. Ceraski.** (Astronom. Nachr. No. 4375. Nature, 82. p. 228, Dec. 23, 1909. Abstract.)—On a plate taken March 23, 1909, at 10h. 6m. to 12h. 6m. (Moscow mean time) an image was found in a position that was vacant on 24 previous plates, showing stars down to 12·5 magnitude. The star's approximate position is $\alpha = 8h.\ 29m.\ 26s.$; $\delta = +58°\ 50'$ (1900). C. P. B.

337. *Polarisation of Skylight.* **W. Krebs.** (Phys. Zeitschr. 10. pp. 1025–1026, Dec. 15, 1909.)—Busch's polariscopic observations were mainly restricted to the solar vertical. When observations are extended over the whole sky, fields of positive and negative polarisation reveal themselves, the former by one, the latter by two, dark bands among the coloured bands, for the vertical

position of the instrument. These fields are separated by neutral bands, in which the neutral spots of Arago and Babinet are indicated by bends or depressions. With perfectly clear sky the writer repeatedly found, when facing either towards or away from the sun, the band mounting on the left bent sharply at 90° towards the zenith. This would mean a rectangular zenithal field of positive polarisation cut out of the region of negative polarisation lying nearer the horizon. On cloudy days there were changes in the position of the bands. It seems hardly advisable, however, to reject all observations on cloudy days, as too many gaps in the continuity of series would invalidate results. The writer made a series of observations at Gross-Flottbek in June–July, 1909, comparable with Busch's series at Arnsberg in 1886–1889. The difference of results for the Arago point is nearly constant in June and July, but the Babinet point shows a mean rise of nearly 3° in July at Gross-Flottbek, which is attributed to volcanic outbursts in Samoa, Tonga, &c. Busch also found the Babinet point to be more sensitive to volcanic atmospheric effects than the Arago point, the former showing four times the shift of the latter. Continuation of the author's observations to the end of Aug. showed a further mean rise of 0·8° for the Arago, 0·5° for the Babinet point. A. E.

338. *Intrinsic Brightness of the Starry Sky.* **C. Fabry.** (Comptes Rendus, 150. pp. 272–275, Jan. 31, 1910.)—Newcomb stated that this may be considered as one of the fundamental constants of astrophysics, and made a rough attempt at measurement. He found: (1) that the intrinsic brightness of the sky in the most brilliant portions of the Milky Way is only 2 or 3 times that of the non-galactic region; (2) that a square degree of sky outside the Milky Way is equivalent to 1·15 stars of magnitude 5. The author employed photography. An objective ($f = 48$ cm.) has, in its focal plane, a diaphragm pierced with a circular aperture the diam. of which can be varied. The light which has passed through this aperture falls upon an optical system, similar to a microscope objective, having short focus ($f = 3{\cdot}15$ cm.) and large angle, which projects upon the photographic plate an image of the object-glass in the form of a small circle of uniform brightness. The illumination of this circle is due to light from all points of the sky throwing an image within the diaphragm aperture. The measurement of intrinsic brightness of a given region of the sky requires two successive measures: (1) on a single comparison star (Pole Star), with very small diaphragm aperture; (2) on the region studied, the diaphragm aperture being adjusted until the same impression is produced as in the first case. In a region not far from the Pole, and 30° from the Milky Way, the intensity of a square degree is found equal to 0·103 of the polar, or to 0·92 stars of photographic magnitude 5. In a region of Cygnus, in the brightest part of the Milky Way, a square degree is equivalent to 0·212 of polar, or to 1·90 stars of phot. mag. 5. The phot. mag. adopted for Polaris is 2·62; if a value equal to its visual magnitude 2·12 were adopted instead, then a non-galactic square degree would be equivalent to 1·46 stars of magnitude 5, instead of 0·92. Kapteyn's researches tend to indicate a great variation of intrinsic brightness with distance from the galaxy. Pickering's values attribute much less importance to the galaxy, but lead to values for intrinsic brightness only half as great. If it could be shown that the sum of the intensities of the observable stars is notably inferior to the total intensity of the light of the sky, then the existence might be inferred either of an immense number of stars too faint for observation, or of a kind of uniform nebulosity. A. E.

REFERENCES.

339. *Calibration of the 2,400,000-lb. Hydraulic Testing Machine of the Phœnix Iron Co. by Comparison with the Watertown Arsenal Emery Machine.* (Eng. News, 62. pp. 377–378, Oct. 7, 1909.)—An account of tests made by J. E. Howard.

340. *Stresses in Reinforced-Concrete Beams.* **G. Lanza** and **L. S. Smith.** (Amer. Soc. Mech. Engin., Journ. 31. pp. 1035–1046, Mid.-Oct., 1909; Discussion, 32. pp. 83–118, Jan., 1910.)—Takes the three theories—(1) the usual one; (2) that of A. N. Talbot; and (3) that of Considère—and applies the results of experimental tests described in the paper to the determination as to which formula represents the experimental results most accurately. It is concluded that whichever of the theories is adopted it can only be regarded as a sort of working hypothesis. L. H. W.

341. *Rankine-Gordon and Euler's Formulæ for Columns.* **W. E. Lilly.** (Engineering, 89. pp. 33–34, Jan. 14, 1910.)—Points out the practical advantages of the Rankine-Gordon formula.

342. *Stresses due to Bending and Twisting, and the Design of Shafting.* **A. L. Jenkins.** (Engineering, 88. pp. 637–639, Nov. 12, 1909.)—Unsuitable for treatment in a brief Abstract.

343. *Non-Newtonian Mechanics.* **H. Poincaré.** (Rev. Électrique, 13. pp. 23–28, Jan. 15, 1910. Paper read at Congrès de Lille de l'Assoc. franç pour l'avancement des Sciences.)—A *résumé* and exposition of the newer views as to inertia and velocity, the principle of relativity, apparent time, the deformation of bodies in movement, astronomical considerations, Lorentz's new hypothesis as to a residual effect accounting for gravity and as to the necessary extensions of Newton's law that inertia is proportional to mass. A. D.

344. *Bodies considered Rigid in the Relativity Principle.* **G. Herglotz.** (Ann. d. Physik, 31. 2. pp. 393–415, Jan. 28, 1910.)—Mathematical treatment on the basis of the Lorentz contraction hypothesis and the geometry of four-dimensional space, with special reference to the papers by M. Born and by P. Ehrenfest. [See also Abstracts Nos. 1723 (1909) and 13 (1910)]. E. H. B.

345. *Number of Degrees of Freedom of a Molecule among which the Partition of Energy is governed by the Principal Temperature.* **H. Bateman.** (Manchester Lit. and Phil. Soc., Mem. 53. 1. pp. 1–9, 1908–1909.)

346. *Theory of Impact and its Application to Testing Materials.* **H. D. Tiemann.** (Frank. Inst., Journ. 168. pp. 235–259, Oct., and pp. 336–364, Nov., 1909.)—A complete monograph on the subject, the work of A. Gessner being largely quoted and drawn upon. L. H. W.

347. *Experiments on the Actual Strength of [-shaped Beams.* **C. Bach.** (Zeitschr. Vereines Deutsch. Ing. 53. pp. 1790–1795, Oct. 30, 1909.)—The original pages should be referred to for the tables of results

348. *Auroral Displays and Magnetic Storms of September,* 1908. **W. R. Gregg.** (Mount Weather Observatory, Bull. 2. 1. pp. 19–28, 1909.)—Notes are given of the auroral displays observed at Mount Weather, Va., during Sept., 1908. The times of the phenomena are compared with the readings of the Wild magnetograph and with the observations of sun-spots. It is pointed out that auroræ have been very frequent about 1728, 1787, 1847, 1908, thereby showing a variation with a period of about 60 years. A. D. R.

349. *Preliminary Note on Photographing Mars with a 30-in. Refractor.* **G. A. Tikhoff [Tichov].** (Acad. Sci. St. Pétersbourg, Bull. 15. pp. 1039–1042, Nov. 1, 1909.)—The author has taken photographs of Mars with a 30-in. refracting telescope, the diam. of the image on the sensitive plate being about 1·5 mm. In order to intensify the contrast between the light and dark parts of the planet, red, green, and yellow light-filters were employed. T. H. P.

350. *Constants of Moon's Physical Libration.* **F. J. M. Stratton.** (Roy. Astronom. Soc., Mem. 59. 4. pp. 257–290, 1909.)—The paper deals with the determination of the physical libration of the moon, produced by the attraction of the earth and sun on the ellipsoidal satellite. A fresh reduction is made of Schlüter's observations, in the hope of reconciling the constants obtained by Franz and Hayn. This hope is not fulfilled, the net result being a confirmation of the results of Franz. C. P. B.

351. *Secular Acceleration of Moon's Mean Motion.* **E. W. Brown.** (Roy. Astronom. Soc., M.N. 70. pp. 143–148, Dec., 1909.)—The paper arises from a statement by Newcomb that "on account of the effect due to the combination of the earth's oblateness with the secular diminution of the obliquity of the ecliptic," a correction of 0·27 had been added to the secular acceleration of the moon's mean motion [see Abstract No. 620 (1909)]. The author proceeds to describe his analytical method for the determination of the correction, employing the notation used in his new theory of the moon's motion. C. P. B.

352. *Path of the Planetoid Egeria* (13). **H. Samter.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 50. pp. 1239–1253, 1909.)

353. "*Geometrical*" *Canals on Mars.* **R. G. Aitken.** (Science, 31. pp. 114–115, Jan. 21, 1910.)—The writer suggests as a possible method of coming to an agreement concerning the reality or otherwise of the reticular markings on Mars, that two or three of the accepted authorities on Martian observation—say, E. E. Barnard of Yerkes, W. H. Pickering of Harvard, and E. W. Antoniadi of Juvisy—should be invited to Flagstaff to compare observations with Lowell, all using his 24-in. refractor. In this way many of the important differences due to situation, instrument, and weather conditions would all be eliminated. C. P. B.

354. *Spectrum of a Meteor.* **W. P. Fleming.** (Science, 30. p. 734, Nov. 19, 1909. Paper read before the Astronom. and Astrophys. Soc. of America.)—On a photograph taken with the 24-in. Bruce telescope on May 18, 1909, at Arequipa the spectrum of a meteor was found during the examination of stellar spectra. The trail is very intense, and consists of 23 bright lines or bands. No identifications of these have yet been made. C. P. B.

355. *Star Colours and Spectral Types.* **W. S. Franks.** (Roy. Astronom. Soc., M.N. 70. pp. 187–194, Dec. 10, 1909.)—The paper consists of a series of tabular correlations of star colours and spectral types, the latter being taken from the Harvard results. C. P. B.

356. *Meteor Tracks.* **G. v. Niessl.** (Akad. Wiss. Wien, Sitz. Ber. 118. 2a. pp. 759–821, June, 1909.)—A summary of all available observations of three well-marked meteors—those of Dec. 12, 1904; Feb. 8, 1905; July 11, 1906, and the particulars of their paths computed therefrom. C. P. B.

357. *Light-variation and Elements of β Lyræ.* **J. v. Hepperger.** (Akad. Wiss. Wien, Sitz. Ber. 118. 2a. pp. 923–957, June, 1909.)—Discussion of light-curve of the variable bright-line star β Lyræ, with a derivation of the probable elements of the body regarded as a multiple system. C. P. B.

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358. *Open-air Telescope.* **S. A. Mitchell.** (Scientific American, 102. pp. 97 and 104, Jan. 29, 1910.)—Illustrated description of a novel form of mounting for a large refractor, completed some time ago by F. S. Archenold, at Treptow, Berlin. The objective, 27 in. in diam., is fixed at the end of a composite tube 69 ft. long, counterbalanced so as to revolve about an axis near one end. This axis is carried by a large fork built up of iron plate, and constituting the polar axis of the instrument. The observer stands in the middle of the fork at the eyepiece, and has not to change his position for observing stars of any altitude. No dome is provided, and when not in use, the telescope is placed horizontally and covered with a simple sliding roof. Electric motors are provided for following the celestial objects and for setting on different positions. The cost of the completed instrument (objective by Steinheil of Munich) was $62,500 (£12,500). C. P. B.

359. *Photographic Enlargement.* **A. Schmidt.** (Phys. Zeitschr. 11. pp. 50–53, Jan. 15, 1910.)—Describes a photographic method of enlarging diagrams, at the same time producing additional enlargement in one direction. There are many methods of obtaining simple enlargements, but only few methods enable the ratio of the scales to be altered, and even with these the ratio of the enlargements in two directions at right angles to one another is fixed for each apparatus used. In Rudolf's method, for example, the ratio of the magnifications is altered by the use of a specially made lens, and a different lens is required for each alteration of the ratio. A method giving any required alteration of the scale ratio is of particular use in comparing, say, the variation of the elements of the earth's magnetism as recorded at different parts of the world. Each observatory secures records with its own arbitrary units for time and angular motion of magnets. Hence a method which will enable all such records to be obtained on the same scale is of interest and importance. In the author's method, the curve to be copied is mounted on a cylinder (A) which is capable of rotation about its axis. In front of A is an arrangement of two cylindrical lenses and a camera with an ordinary lens. The sensitive paper is mounted on a drum (B) whose axis is parallel to that of A and to the axes of the cylindrical lenses. The lenses are arranged so that a line on A is focussed as a line on B, the ratio of the lengths of the two lines being determined by the relative distances of A and B from the camera lens. If now B is caused to rotate *m* times as fast as A, the abscissæ will be multiplied by *m*, and this factor may be easily altered at will by simple mechanical means. Thus the two magnifications are quite independent of one another, and each may be varied in any desired manner. A. W.

360. *A New Step in Ultramicroscopy.* **H. Siedentopf.** (Deutsch. Phys. Gesell., Verh. 12. 1. pp. 6–47, Jan. 15, 1910.)—After recounting the optical conditions necessary to make ultramicroscopic particles visible, a description is given of a new luminous ultramicroscope and of its manipulation. Complete "dark field illumination," *i.e.*, illumination round the edge of a central screen or stop, is attained by means of two dark field condensers, the paraboloid or the cardioid condenser. The aplanatism of the latter depends on a remarkable, hitherto unknown property of the cardioid. The efficiency of the new apparatus is due, in addition, to special quartz chambers and new objectives. Work with the instrument is described, including new observations on the Brownian movement, on the shape of ultramicroscopic metal particles, on microchemical reactions and light reactions. The reduction of white silver bromide in water to polychrome silver particles resembling a Lumière autochrome plate is also described with the aid of coloured drawings. [See also Abstract No. 75 (1906).] G. E. A.

361. *Refraction and Dispersion of Neon.* **C.** and **M. Cuthbertson.** (Roy. Soc., Proc. Ser. A. 83. pp. 149–151, Jan. 7, 1910.)—The refractivities were found to be as follows:—

$\lambda \times 10^8$.	$(\mu - 1)10^6$.
6438	134·02
5461	134·30
4800	134·63

and the refractivity may be expressed in Cauchy's formula—

$$\mu - 1 = 0{\cdot}0001332(1 \times 2{\cdot}38/\lambda^2).$$

Appended to the paper are the values of $\mu - 1$ for all the inert gases in the form of Sellmeier type, corrected for a redetermination of the dispersion of air ($b = 5{\cdot}8 \times 10^{-11}$). E. C. C. B.

362. *Refraction and Dispersion of Air, Oxygen, Nitrogen, and Hydrogen.* **C.** and **M. Cuthbertson.** (Roy. Soc., Proc. Ser. A. 83. pp. 151–171, Jan. 7, 1910.)—The refraction and dispersion for these gases have been accurately determined, light of wave-lengths 6563, 5790, 5461, and 4061 being employed. It is found that Cauchy's formula is inadequate and that Sellmeier's equation is more satisfactory, $\mu - 1 = C/(n_0^2 = n)$, where n_0 and n are the frequencies of free vibration of the atom and of the incident light respectively. The values previously obtained are also given, recalculated in the same form. According to Drude's theory, C in the above equation is proportional to the number of electrons in unit volume of the medium, and from the values given in the paper the number of dispersion electrons in the elements H, O, N, S, and P are in the ratio of 1, 2, 3, 3, and 4½ respectively. E. C. C. B.

363. *Refraction and Dispersion of Sulphur Dioxide and Hydrogen Sulphide.* **C.** and **M. Cuthbertson.** (Roy. Soc., Proc. Ser. A. 83. pp. 171–176, Jan. 7, 1910.)—The refractivities and dispersion of SO_2 and H_2S were determined, and it was found that the former is not in either case the sum of those of the constituents. On the other hand, within the limits of experimental error the number of dispersion electrons in SO_2 is found to be the sum of those in S_2 and O_2. This is not the case with H_2S, which apparently contains one more dispersion electron than H_2 and S. E. C. C. B.

364. *Low-temperature Optics.* **J. Dewar.** (Engineering, 89. pp. 116–117, Jan. 28, 1910. Discourse delivered at the Royal Inst., Jan. 21, 1910.)—In studying the action of light at low temperatures, care must be taken that the light-radiation does not produce local heating. That light rays could call forth decomposition was demonstrated by periodic acid; the greenish

vapours were transformed into a thick mist by a beam of light. To show that colour changes with temperature, a piece of cardboard, coated with the bright-red iodide of mercury, was dipped into liquid air; the colour at once changed into yellow. Solid paraffin became phosphorescent when exposed to light while kept in liquid air. Gelatin also became phosphorescent, ivory showed a greenish phosphorescence. The white of egg, solidified by pouring liquid air on it, displayed a beautiful blue phosphorescence. The formation of ozone when light falls on liquid oxygen was demonstrated by the iodine starch paper test. E. H. B.

365. *Dispersion of Light in Space.* **E. B. Frost.** (Science, 30. p. 728, Nov. 19, 1909. Paper read before the Astronom. and Astrophys. Soc. of America.)—Examination of plates of spectroscopic binaries, taken with the Bruce spectrograph of the Yerkes Observatory, does not give evidence of any difference of radial velocity for different wave-lengths. The star β Cephei, having a period of 4h. 34m., is specially suitable for this investigation. On plates of the star μ Orionis, with a short period of 0·77 day, the spectrum is composed of very sharp lines, and the measurement of these shows no difference of velocity. The conclusion is that there is no spectroscopic evidence of dispersion of light in space.

C. P. B.

366. *Photographic Photometry.* **J. A. Parkhurst.** (Science, 30. p. 726, Nov. 19, 1909. Paper read before the Astronom. and Astrophys. Soc. of America.)—From a series of experiments with the object of obtaining a satisfactory system of stellar photometry, a number of points requiring careful attention in every case are enumerated, dealing with both focal and extra focal images. (1) Various developers may give very different gradation. (2) Varying times of development may introduce errors of as much as one magnitude. (3) The error depending on the temperature of development may be one magnitude for a range of 10° F. (4) Sky fog on the plate, up to half a magnitude; (5) temperature of exposure, (6) reduction formulæ for diameters of star discs, (7) atmospheric absorption, (8) curvature of commercial plates, all may give errors of varying amounts up to about half a magnitude. (9) Corrections for distance of the stellar image from the axis of the telescope amounted to 0.33 mag. at 3° from the axis of a Zeiss doublet. For coloured stars of the solar type a correction of as much as one magnitude is possible. C. P. B.

367. *Terrestrial Reproduction of Comet Tail Spectra.* **A. Fowler.** (Roy. Astronom. Soc., M. N. 70. pp. 176–182, Dec. 10, 1909.)—The bands attributed to carbon which have been long recognised as characteristic of the majority of comets have for many years been supposed to be present also in the spectra of comets' tails. In the case of Daniel's comet (1907d), however, it was found by Deslandres [see Abstract No. 1808 (1907)] that while the head showed the ordinary characteristic spectrum, the tail exhibited a spectrum consisting of three lines or bands of unknown origin. A similar result was obtained by Evershed [Abstract No. 220 (1908)]; the strong cyanogen band was restricted to the head. Using a more powerful instrument, Chrétien, at Nice, found that the three new bands were each double, with the wave-lengths 4012, 4020; 4253, 4275; 4503, 4542. In the remarkable Comet Morehouse (1908*c*) these double bands were again characteristic. A notable feature was the presence of a single band at λ3914. In view of the probable

low density of gases in the tails of comets, the most promising field of investigation apparently lay in the spectra of high vacua, and a systematic search among various types of kathode spectra was undertaken. On a photograph taken in 1902 a series of double bands occur, which are practically reproductions of the new cometary bands. From this terrestrial spectrum, taken with a slit spectrograph, the positions of the bands have been more accurately determined, and are as follows: 3914·8; 4001·3, 4021·0; 4252·6, 4276·5; 4545·6, 4569·9; 4688·5, 4714·1. Accompanying the paper is a reproduction showing the spectrum of the comet obtained by Frost and Parkhurst, and for comparison a copy of the terrestrial spectrum. In the attempt to trace the origin of the new bands compounds of carbon with hydrogen, nitrogen and oxygen, were examined. When the discharge was brightly luminous, the CO flutings were visible in each case, and the new bands appeared when the pressure was so reduced that only slight luminosity remained. The conclusion is that the double bands are due to some modification of carbon. C. P. B.

368. *Radial-velocities with Objective Prism.* **F. Schlesinger.** (Science, 30. p. 729, Nov. 19, 1909. Paper read before the Astronom. and Astrophys. Soc. of America.)—It is proposed to employ two photographic doublets of about 6 in. aperture and as nearly as possible equal focal lengths. Before the objective of each will be placed a prism of the same aperture, the refracting edge of one being turned towards the north, and of the other to the south. The sensitive plates will be of plate glass, and one of them will be turned so that the glass side is towards the objective. Differences produced by temperature-changes would be obviated by surrounding the entire spectrograph with a temperature case supplied with an automatic temperature control. The plates are to be measured by superimposing them and obtaining the distance between corresponding lines in the two spectra of each star, these distances being affected with the radial velocity. It is concluded that with such an instrument the radial velocities of faint stars could be determined with a probable error not exceeding 10 km. for each pair of plates. C. P. B.

369. *Physiological Principles underlying the Flicker Photometer.* **J. S. Dow.** (Phil. Mag. 19. pp. 58–77, Jan., 1910. Paper read before the Physical Soc., Nov. 12, 1909. Electrician, 64. pp. 588–591, Jan. 21, 1910. Abstract.)—The author has previously discussed the phenomena of colour vision which are of importance in connection with heterochromatic photometry [see Abstract No. 1560 (1906)]. He also pointed out that his experimental results indicated that the physiological basis on which the working of "equality of brightness" photometers depended was different from that on which flicker photometers depended. He now summarises the results of further experiments which throw light on the theory of the working of the flicker photometer. His experiments prove that the Purkinje and the yellow-spot phenomena are very much weaker when the flicker method is used. The suggestion is made that the time taken by a "rod" of the retina to record and preserve a luminous impression is different from the time taken by a "cone." A. R.

370. *Actinic Value of Different Lamps.* **P. v. Schrott.** (Zeitschr. wiss. Phot. 8. pp. 25–32, Dec., 1909.)—Vogel's silk-paper actinometer-scale has an absorption-constant of 1·288 per thickness for a Scheiner benzine lamp with AgBr gelatine; with a 110-volt 40·25-hefner metallic filament lamp (1·2 watts

per hefner) it is 1·86 with AgCl normal paper (Bunsen's, Eder's Handb. d. Photogr. 2nd edition, part i. vol. i. p. 388, 1892); with an ordinary white arc 1·488, with a white or yellow effect arc 1·588, with a mercury vapour lamp 1·74; in all cases with a thin glass interposed, which cuts off ultra-violet rays beyond λ3000. The violet and ultra-violet rays are more strongly absorbed by the paper. For comparison of lamps AgCl nitrited paper was used (Eder, Phot. Korresp. July, 1909). The comparison tint was 1000 ZnO, 10 turpentine lampblack calcined. The distances from the lamps were adjusted so as to make the exposures equal for equal effects. The results reduced to 1m. distance for equal times gave the relative chemical effects, for AgCl paper and for yellow bichromated gelatine pigment paper respectively, as follows: 40½-hefner metallic filament lamp, 0·414, and ——; 1010-hefner red effect arc, 58·2 and 18·8; 1990-hefner yellow effect arc, 82·5, 25; 2500-hefner ordinary arc, 145, 64·5: 1990-hefner white effect arc (bluish), 820, 6·1; 2940 HK. do. (reddish), 855, 7·4; ordinary 765-hefner mercury vapour lamp, 58, 6·7; 1800-hefner quartz mercury vapour lamp, 267 and 16·7. With these lamps the respective absorptions of ultra-violet rays by a thin glass (as compared with rock-crystal) were: —, 50, 87, 80, 25, 45, —, 88 per cent. The quartz mercury vapour lamp works out the most economical consumption of current for silver paper, one-third that of a bluish-white effect arc: with bichromated gelatine the consumptions with these two lamps are the same. The quartz lamp takes 10 min. to come up to full chemical efficiency, but the smallness of its source of light is of great advantage. A. D.

371. *Illuminating Power of Groups of Pin-hole Burners.* **R. G. Harris.** (Roy. Soc. Edinburgh, Proc. 30. pp. 46–62, 1909–1910.)—The object of these experiments is to study the variation in illuminating power of symmetrical groups of pin-hole burners placed at different distances apart. The burners are arranged in a framework, and the illuminating power of the whole arrangement is compared with that of a single similar pin-hole burner. Groups of two, three, and four burners are tested, and graphs connecting the distance apart of burners and illuminating power are plotted. In each case the function is of an exponential nature. In the case of two burners the illuminating power gradually falls as the burners are separated. In the case of groups of three or four, however, the curve first rises and then falls subsequently. This last effect is ascribed to the fact that the close proximity of the burners to each other alters the conditions as regards draught, &c. J. S. D.

372. *Daylight Efficiency of Artificial Illuminants.* **H. E. Ives.** (Bureau of Standards, Bull. 6. pp. 231–246, Nov., 1909. Electrician, 64. pp. 932–934, March 18, 1910.)—The author suggests that there is a need for some method of estimating the resemblance of artificial illuminants to daylight, *i.e.*, of determining their "daylight efficiency." Assuming that, by the extraction of certain qualities of light in an illuminant its colour could be brought to resemble that of daylight very closely, the daylight efficiency of a source might be expressed in the form (intensity of available white light)/(total intensity of source). The author suggests two methods of studying this question. The first is based upon the use of suitable absorbing screens which, as explained above, could be used to bring the colour of an illuminant into near agreement with daylight, though reducing its intensity in doing so. The author presents some spectrophotometric curves of various sources of light, and a diagram illustrating the amount and nature of light from the various sources which must be absorbed to produce white light.

He also tabulates the "daylight efficiency" of a number of artificial illuminants. The method, however, is of practical rather than of scientific interest since it depends upon the particular wave-length for which the intensity is assumed to be unity, when plotting the spectrum curves. In addition, "selective" sources such as the mercury arc lamp, which yields a spectrum consisting of isolated bright lines, would work out to have a zero efficiency according to the above method. Yet, if we judge by sensation such sources contain a certain amount of white light. The author then proceeds to discuss a second method based on the fact that any colour can be matched by a mixture of white light and one ray of the spectrum. The ratio of the white light used in attaining such a match to the intensity of the source studied is then regarded as an alternative method of defining white light efficiency, which the author in this case terms "white sensation efficiency." He points out that classification on this method gives rise to materially different results from those arrived at by the former method. The efficiency in the case of the second method appears to be higher. Yet the result gives no indication of the ability of the source to reveal colours of surrounding objects, and merely indicates the colour of a white surface illuminated by the source. In conclusion, the author remarks that the first method is preferable from the practical standpoint, and the latter from the purely scientific one. J. S. D.

373. *Photographic Methods for Spectrophotometry.* **P. P. Koch.** (Ann. d. Physik, 30. 5. pp. 841–872, Dec. 14, 1909.)—A method for spectrophotometric measurement based upon the photography of the two spectra to be compared and the calculation of the relative intensities from the densities of the photographs so obtained. The comparison is made between the densities obtained at any given wave-length, and the intensities are deduced from the relation $i_1 t_1^\theta = i_1 t_2^\theta$, where i_1, i_2 are two intensities and $t_1 t_2$ the corresponding densities and θ is a function of the plate and developer only. E. C. C. B.

374. *Influence of a Magnetic Field on the Quenching of Luminous Vibrations.* **J. Becquerel.** (Comptes Rendus, 149. pp. 1364–1366, Dec. 27, 1909.)—Dufour has imagined a quenching of the light-rays by the magnetic field in order to explain certain asymmetries in intensity in the resolved lines. In the case of the bands, 587 of xenotime, and 399·6 of tysonite observed at very low temperatures, asymmetry in the intensity is very noticeable. This, the author agrees, may be explained partly by a variation in the quenching of the rays, but it cannot entirely be due to this. E. C. C. B.

375. *Luminescence Phenomena in Crystals.* **A. Pochettino.** (N. Cimento, 18. pp. 245–300, Oct., 1909.)—The author has examined 227 samples of crystalline minerals belonging to 78 species, and representing all the crystalline systems, to ascertain whether they exhibit luminescence. Of these species, 18 give no trace of luminescence under any conditions, 60 give it when exposed to the kathode rays, 28 when exposed to the anode rays, whilst 20 give phosphorescence, 14 thermo-luminescence, 3 electro-luminescence, and 4 tribo-luminescence. The results are described in detail. T. H. P.

376. *Relation between Absorption and Phosphorescence.* **L. Brüninghaus.** (Comptes Rendus, 149. pp. 1124–1127, Dec. 13, and pp. 1375–1377, Dec. 27, 1909.)—The best known phosphorescent substances consist of dilute solid solutions of "phosphorogens" in diluents, the phosphorogens, to which belongs the emission of light, being usually absorbents, whilst the diluents are transparent. It would therefore be expected that a relation exists between the spectra of absorption and phosphorescence of a given phosphorogen. In order to ascertain whether this is the case, the author has compared the two spectra for various rare earths. The results are what would be expected if the light emanated from phosphorogenic molecules situate within the phosphorescent matter, and were subjected to the absorption of the superficial layers, so that the radiations observed at the exterior of the matter are only those for which the phosphorogen is comparatively transparent. It follows that an increase in the concentration of the phosphorogen is accompanied by two actions of opposite sense: (1) increase of the number of emissive molecules, and, consequently, of the intensity of the light radiated by the active layer, proportional to the concentration; (2) increased absorption of the radiated light, since the light transmitted by an absorbent layer of constant thickness is proportional to the quantity e^{-Bc}, e being the base of the Napierian system of logarithms, B a constant of the phosphorogenic matter characterising its absorbing power for the radiations considered, and c the concentration of the phosphorogen. According as one or other of these factors predominates, the light increases or diminishes in intensity. These views are supported to some extent by experimental numbers obtained. T. H. P.

377. *Fluorescence Absorption.* **J. B. Burke.** (Nature, 82. p. 279, Jan. 6, 1910.)—A criticism of Wood's work upon fluorescence absorption [see Abstract No. 454 (1909)]. Wood compared the light apparently transmitted by a fluorescent body when fluorescence is and is not taking place, and found that there is no difference in the resultant effect. The author says that Wood's inference that there is no difference in the absorption is wrong, for the total amount of emergent light must be increased by the fluorescent light when the body is fluorescing; and that since the total light is the same in the two cases, it is evident that the amount of absorption of the transmitted light is increased during fluorescence. E. C. C. B.

378. *Variation of Gas Phosphorescence with Pressure.* **C. C. Trowbridge.** (Phys. Rev. 28. pp. 386–388, May, 1909. Abstract of paper read before the Amer. Physical Soc., Feb. 27, 1909.)—The relation of gas phosphorescence to pressure was found to be $I_0 = Cp^3$, where I_0 is the original pressure and p the pressure. The difference in rate of decay of gas phosphorescence at different pressures has also been determined. If, in any case of decay, $1/\sqrt{I}$ for each intensity is plotted with the corresponding times, a straight line is formed, the equation being $1/\sqrt{I} = a + bt$. In this, the b measures the rate of decay; and if the b's are plotted with the corresponding gas pressures, a smooth curve is obtained which follows closely the form of a parabola. E. H. B.

379. *Polarisation of Röntgen Rays.* **W. R. Ham.** (Phys. Rev. 30. pp. 96–121, Jan., 1910.)—By direct observation on the primary Röntgen rays it was found that a polarisation exists and is independent of the position of the normal to the target. The max. intensity is, within experimental error, in the plane through the target normal to the kathode-ray stream, and the intensity falls off symmetrically on either side of this plane. The polarisation is affected by the p.d. alone, and increases with a decrease of p.d., as is to be expected from the ether-pulse theory. The interposition of sheets of silver and tin causes an increase in polarisation which reaches the same upper limit for both metals. Lead decreases the polarisation, but no lower limit

was observed. Aluminium, paper, and glass cause very slight change, if any, in the polarisation. All the observed results are completely explained if it be assumed that the ordinary Röntgen-ray beam consists of a mixture of primary and secondary rays originating in the target, and that the secondary rays are completely unpolarised. Various further observations on the behaviour of Röntgen rays were made and the following results were obtained: The coefficient of absorption for lead is a constant, within experimental error, at a p.d. of 14,000 volts. The coefficient of absorption of tin decreases slightly as thicker sheets are used in determining it. Silver shows a different absorption at 90° from that shown at 80°. The coefficient of absorption decreases as the hardness of the tube increases. The mean depth at which the Röntgen rays originate in a lead target is proportional to the p.d., and at a p.d. of 21,500 volts is $5{\cdot}9 \times 10^{-4}$ cm., which is of the order of the wave-length of sodium light. The thickness of lead required to produce a complete scattering of a Röntgen-ray beam is proportional to the p.d., and at a p.d. of 90,000 volts is $2{\cdot}5 \times 10^{-4}$ cm. J. J. S.

380. *Radio-activity of Potassium Salts.* **J. C. McLennan.** (Phys. Rev. 29. pp. 489–506, Dec., 1909. Paper read before the Royal Society of Canada, May 26, 1909.)—The radio-activity of potassium salts was investigated by the method in which one vessel is placed within, and insulated from, a second and the electrical charge which the insulated body or vessel more or less rapidly acquires is then observed. Preliminary experiments were made on the charging action of the radiation from polonium, and that of the secondary rays excited in Al by the γ-rays from Ra; the charges acquired by Ur salts at low pressures were also observed. In the case of potassium salts the results show that in high vacua both potassium nitrate and potassium sulphate emit an excess of charged particles of the β-type. The effect observed in all cases was small and it required exceptional conditions to bring it into evidence. It was not found possible to decide whether any radiation of the α-type is emitted by the potassium salts or not. J. J. S.

381. *Radio-activity of Haloid and Oxy-haloid Compounds of Thorium.* **J. Chaudier** and **E. Chauvenet.** (Comptes Rendus, 150. pp. 219–221, Jan. 24, 1910.)—The radio-activity of these compounds in quantities containing more than about 0·010 gm. of Th varies with the nature of the elements associated with the Th, the intensity of the radiation diminishing as the atomic weight of these elements increases. This variation seems to be due to the absorption of the radio-active radiation in the interior of the layer of substance by the elements entering into the constitution of the molecule; the absorption apparently tends towards a limit as the thickness of the layer increases. This absorption of the thoric rays by the substance which emits them must be of considerable intensity, since the rays from the lower layers produce but little effect. The radio-activity curves for the different Th-compounds approach that for Th and coincide with it for sufficiently small quantities—less than 0·010 gm.—of substance. Support is thus lent to Mme. Curie's view that thoric radio-activity is an atomic property. T. H. P.

382. *Recoil of Radium C from Radium B.* **W. Makower** and **S. Russ.** (Phil. Mag. 19. pp. 100–115, Jan., 1910. Paper read before the Physical Soc., Nov. 26, 1909.)—If a plate is exposed as negative electrode in an electric field

to RaEm for a long time, RaB, RaA, and RaC will be found on the plate after removal from the emanation, but if the plate is then left for half or three-quarters of an hour the RaA on the plate will have diminished to a small fraction of its initial value, and there remain only RaB and RaC which are being transformed respectively into RaC and RaD. It is, however, found possible only under certain conditions to study the recoil of RaC from RaB without the interference of secondary disturbances. The conditions of obtaining pure RaC by recoil are fully considered, and it is found that even under the best experimental conditions there is still a small quantity of RaB mixed with the RaC. The proportion of RaC which reaches the disc owing to recoil, varies in the experiments from $\frac{1}{1000}$ to $\frac{1}{100}$ of the total quantity which could have reached it. It seems not unreasonable to imagine that, on account of the smallness of the energy of recoil of the RaC particles it is only those particles which come off normally or in directions making small angles with the normal to the plate, that succeed in getting away from the plate beyond the range of molecular attraction. To test the correctness of this view, the variation with the distance of the amount of RaC received by a disc exposed *in vacuo* at different distances from the radiating plate is ascertained. The deviation of the experimental curve indicating the variation of activity with the distance, from that obtained on the supposition that the particles are radiated in all directions at random, seems, however, insufficient to entirely account for the smallness of the fraction of RaC particles which succeed in getting free from the radiating surface. RaA and RaB when expelled as the results of a recoil of an α-particle, can penetrate only about 40 times as much air without being stopped as RaC when it recoils as the result of the emission of a β-particle from RaB. The order of magnitude of the absorption of RaC is, therefore, far smaller than anticipated. If an α-particle of slow velocity were expelled during the transformation of RaB into RaC this difficulty would be removed, but such a process seems extremely unlikely to take place. Some RaC is found on the back of the plate exposed to RaB. The excess of activity which is always found on the front of such a plate is due not to diffusion, but to RaC projected directly to the disc. All attempts to stop the recoiling RaC by an electric field fail, so that RaC when formed from RaB either remains electrically neutral, or the energy of RaC is, for some unknown reason, greater than has been supposed. A. E. G.

383. *Radio-activity at the Earth's Surface.* **G. A. Cline.** (Phys. Rev. 30. pp. 35–52, Jan., 1910. Paper read before the Royal Society of Canada, May 26, 1909.)—The soil contributes by far the greater proportion of the penetrating radiation present at the earth's surface at Toronto, and by comparison any that may have its source in the atmosphere or in the sun may be considered to be negligible in amount. There are no regular diurnal maxima or minima, but there are changes from day to day which seem connected with concurrent barometric changes. The conductivity is greater when the ground is bare and warm than when it is frozen and covered with snow. Filtering air through cotton-wool still leaves many suspension particles.

A. D.

REFERENCES.

384. *Kathodic Phosphorescence of Rare Earths.* **G. Urbain.** (Annal. Chim. Phys. 18. pp. 222–288, Oct., and pp. 289–376, Nov., 1909.)—An exhaustive paper dealing largely with work which has been published previously. T. H. P.

385. *Optics of Moving Media.* **J. Ishiwara.** (Mathematico-Physical Soc., Tōkyō, Proc. 5. 10. pp. 150–180, Nov., 1909.)—A mathematical treatment on the basis of the electron theory and Einstein's principle of relativity. [See also Abstract No. 2277 (1905).] E. H. B.

386. *Sensation of Binary Whites.* **A. Rosenstiehl.** (Comptes Rendus, 150. pp. 235–238, Jan. 24, 1910.)—Gives a geometrical construction for the components of binary whites in which each binary colour is defined by two points as in the theory of Young. E. H. B.

387. *Spectrograph Design.* **J. S. Plaskett.** (Astronom. Soc. of Canada, Journ. Vol. 3. No. 4. Nature, 82. p. 140, Dec. 2, 1909. Abstract.)—Details of the design and construction of a combination single- or three-prism spectrograph for the Ottawa Observatory. All modern arrangements for the elimination of flexure and temperature variations are adopted, and the instrument is to be mainly devoted to a series of determinations of stellar radial velocities. C. P. B.

388. *Simple Method of Adjustment of a Quartz Spectrograph.* **P. P. Koch.** (Zeitschr. Instrumentenk. 29. pp. 363–365, Dec., 1909.)

389. *Stereo-comparator Attachments.* **C. Pulfrich.** (Zeitschr. Instrumentenk. 30. pp. 1–6, Jan., 1910. Communication from the Zeiss Optical Works.)—Details are given of devices designed for use with the stereo-comparator for various photometric and spectroscopic measurements. To facilitate the measurement of stellar discs a series of graduated dots round an eyepiece micrometer is provided, so that the series may be viewed at the same time as the star field under measurement. C. P. B.

390. *Refraction of Light by Gases and its Application to Analysis.* **L. Stuckert.** (Zeitschr. Elektrochem. 16. pp. 37–75, Jan. 15, 1910.)—In the first part of the paper is described in full an apparatus for the determination of the refractivity of mixtures of gases, full details being given of the application of the method to the quantitative determination of one of the constituents. The second part deals with the absolute determination of the refractivities, with a modified Jamin's instrument, of CO_2, SO_2, CN, C_2H_6, C_2H_4, and C_2H_2. E. C. C. B.

391. *The Photographic Plate.* **W. D. Bancroft.** (Journ. Phys. Chem. 14. pp. 12–83, Jan., 1910.)—A full *résumé* as to methods of preparation, amount of silver in film, sensitiveness of film to light, methods of ripening, limits to ripening, inhomogeneity of emulsion, reducing action of some gelatines, questions of reduction during ripening, theories of ripening, state of silver bromide in film, and behaviour of mixed emulsions. A. D.

392. *Actinium and Ionium.* **B. Szilard.** (Radium, 6. pp. 80–82, March, 1909.)—The object of this research is to demonstrate the simultaneous presence of ionium and actinium in Ur minerals free from Th, and to study simultaneously the reactions of those two elements both in the presence and in the absence of the rare earths. The experiments have been performed with the mineral autunite. The intimate connection which exists between uranium, ionium, and actinium is shown, and the various methods of separation employed are fully discussed. The exact ratio between the quantities of these substances present in the mineral has not been established. A. E. G.

393. *Investigation of the Antimony Spectrum.* **A. Kretzer.** (Zeitschr. wiss. Phot. 8. pp. 45–72, Jan., 1910.)—An examination and measurement of the flame, arc, and spark spectra of Sb. Seven series of lines are established, each obeying Deslandres' law. E. C. C. B.

HEAT.

394. *Thermal Conductivity of Heat-insulators.* **Biquard.** (Comptes Rendus, 150. pp. 268–270, Jan. 31, 1910.)—Describes a method of measuring the conductivity of bad conductors. The material, which is in the form of a circular plate, is surrounded by a guard-ring of copper, as in the method employed by Berget in measuring the conductivity of metals; thus a normal flow of heat through the plate is secured. The heat is supplied to the plate and guard-ring from a copper stove plate, through which flows a current of water maintained at a constant temperature. On the plate and guard-ring are placed concentric boxes which are filled with broken ice, the outer one covering completely the one on the plate, leaving a space between which is filled with rings of cork. Tubes from the bottom of each box serve to collect the water. Copper-constantan couples are used to determine the temperatures at different depths. The whole apparatus is surrounded with cork. When the steady state has been reached, all the heat passing through the plate goes to melt ice in the inner box, and from a knowledge of the amount melted in a given time and also of the temperatures, the conductivity is easily found. Sources of error are discussed, but these are small and can usually be neglected. For temperatures above 100° C. the stove plate is electrically heated and on the top of it is placed a thick plate of copper to make the temperature more uniform. A. W.

395. *Water Equivalent of a Calorimeter.* **W. Swiętoslawski.** (Acad. Sci. Cracovie, Bull. 8. pp. 548–555, Oct., 1909.)—Calorimetric apparatus somewhat resembling Pfaundler's is described, the thermal capacity of which is obtainable by a direct method. The same electric current is passed through two similar resistances enclosed in two identical calorimeters. In a preliminary experiment these are filled with water and the increases in temperature are compared. In the actual test one calorimeter contains water and the other is filled with the liquid under investigation. The data so obtained are sufficient to determine the water equivalent with high accuracy. As the liquids on which experiments are to be made may include electrolytes, the resistance wire is made of Pt wound on a glass tube and thinly coated with a glass film. A. D. R.

396. *Propagation of Flame by Coal-dust in Mine Galleries.* **J. Taffanel.** (Comptes Rendus, 149. pp. 1127–1129, Dec. 13, 1909.)—Tests made in the experimental mine galleries at Liévin show that when a gallery is partially blocked or when it exhibits a sharp bend, the violence of a coal-dust explosion undergoes considerable diminution. Further, when the partial stoppage of the gallery is effected by means of movable and incombustible materials, these are carried along by the gases preceding the explosive flame and exert a cooling action sufficient to prevent the further propagation of the combustion. T. H. P.

397. *Laws of Evaporation.* **P. Vaillant.** (Comptes Rendus, 150. pp. 213–216, Jan. 24, 1910.)—Evaporating from a nearly closed vessel, with only a small opening in its lid, the rate of evaporation of a large number of liquids has been determined, a correction being applied for those which are hygroscopic, and the following table gives the results obtained, F_{20} representing the max. pressures at 20° of the different liquids, the second column the weight of each liquid in millionths of a gm. evaporated per sec., the third the number of molecules which would escape per sec. if F was unity, and the speed of evaporation proportional to F, and the fourth the quotients obtained on dividing these by $F^{4/3}$. These last are approximately the same, with the exception of that for water, which may be explained by assuming the existence of $(H_2O)_3$.

Liquid.	F_{20}	$q \times 10^6$	$q \times F^{-1} \times 10^6 \times M^{-1}$.	$q \times F^{-4/3} \times 10^6 \times M^{-1} = a$.
H_2O	14·4	11·2	3·40	1·290 = 3 × 0·430
CS_2	298	680	8·02	0·452
CCl_4	91	881	2·08	0.444
C_5H_{12} (iso).........	578	1450	8·78	0·449
C_6H_{14} (normal) ...	120	171	2·01	0·408
C_6H_6	75	105	1·87	0·448
C_7H_8	22	27·6	1·87	0·469
CH_3OH	95	82	2·87	0·498
C_2H_5OH............	44	39·7	1·81	0·499
C_3H_7OH............	15·2	12·2	1·89	0·529
C_4H_9OH (normal)	4·2	2·80	0·79	0·467
C_4H_9OH (iso) ...	8·6	5·98	0·85	0·404
$CHCl_3$	160	476	2·19	0·408
C_2H_5Br	887	1678	8·75	0·505
C_2H_5I	110	450	2·87	0·478
$(C_2H_5)_2O$	438	1160	8·28	0·431
$(CH_3)_2CO$	180	298	2·56	0·458
C_6H_5Cl	8·8	11·2	0·99	0·478

It is concluded that the rate of evaporation is given by $q = a\,MF^{4/3}$, a appearing to depend only very slightly on the nature of the liquid.

W. H. St.

398. *Measurement of Temperature of Copper with Optical and Total Radiation Pyrometers.* **G. K. Burgess.** (Electrochem. Ind., N.Y. 7. pp. 845–847, Aug., 1909. Bureau of Standards, Bull. 6. pp. 111–119, Oct., 1909.)—The temperature of molten copper between 1078° and 1288°, and having either a clear copper surface or one of oxide, has been measured with (1) an optical pyrometer of the Holborn and Kurlbaum type, using the Morse principle of disappearing lamp-filament, and (2) a Féry reflecting telescope with gold mirror, the results being compared with those obtained with a thermo-couple immersed just beneath the surface of the copper. With the optical pyrometer and for a metallic surface on the copper the following relations are deduced: Red light ($\lambda = 0{\cdot}65\,\mu$), $t = 1{\cdot}515\,r - 859$; green light ($\lambda = 0{\cdot}55\,\mu$), $t = 1{\cdot}515\,g - 477$, t being the true temperature Cent. of the copper and r and g the apparent temperatures given by the pyrometer, using red and green light respectively. The readings of the optical pyrometer are rather higher when the surface has an oxide coating, the difference for red light being about 100° and for green light about 85°, indicating the relatively greater intensity of the green in light emitted by liquid copper. Temperature measurements with the total radiation pyrometer are much less satisfactory than with the optical pyrometer, the readings being more sensitive to slight change in the properties of the surface. The following relations between

t, the true temperature Cent., and F., the reading of the Féry pyrometer, have been deduced: For a metallic surface, $t = 8{\cdot}55\ F - 1018$, and for an oxidised surface, $t = 1{\cdot}41\ F - 169$. From the results obtained the emissivities of liquid copper and cuprous oxide are calculated, E_r for copper being 0·16 at 1075° and 0·18 at 1275°, and for cuprous oxide 0·66 at 800° and 0·54 at 1100°. W. H. St.

399. *The Constant in Stefan's Law.* **E. Bauer** and **M. Moulin.** (Comptes Rendus, 150. pp. 167–169, Jan. 17, 1910.)—In continuation of previous work [see Abstract No. 115 (1910)] on platinum radiation, it is verified that the emissive power increases with the angle of emission of red rays from a polished surface, but that the power is constant for a rough surface. The increase with angle of emission is much greater for the total radiation than for the red alone. With the data obtained an error in the calculation of Stefan's constant as given before is corrected and the value is now stated as $5{\cdot}8 \times 10^{-12}$ watt cm.$^{-2}$ degree^{-4}, a result in close agreement with that of Kurlbaum. G. E. A.

400. *Nitrogen Thermometer from Zinc to Palladium.* **A. L. Day, R. B. Sosman,** and **E. T. Allen.** (Amer. Journ. Sci. 29. pp. 93–161, Feb., 1910.) —The authors have continued the work of Day and Clement [Abstract No. 1979 (1908)] with the object of establishing the temperatures of fixed points between 1100° and 1550° and of ascertaining the curve followed by the Pt-Rh thermo-element in this region. They have succeeded in reducing the errors met with in measurements with the nitrogen thermometer to about one-fourth of their former magnitude, the chief source of uncertainty still remaining being the distribution of temperature over the surface of the bulb in an air-bath. The melting-points of the metals and salts which have been used as fixed points to establish the new scale are as follows, the corresponding temperatures on the Reichsanstalt scale being given in brackets for comparison: Zn, 418·2 ± 0·3° (419·0°); Sb, 629·2 ± 0·5° (630·6°); Ag, 960·0 ± 0·7° (961·5°); Au, 1062·4 ± 0·8° (1064·0°); Cu, 1082·6 ± 0·8° (1084·1°); pure diopside, 1391·2 ± 1·5°; Ni, 1452·3 ± 2·0°; Co, 1489·8 ± 2·0°; Pd, 1549·2 ± 2·0° (1575°); pure anorthite, 1549·5 ± 2·0°. The following melting-points were also determined: Cd, 320·0 ± 0·3° (321·7°) and Al, 658·0 ± 0·6° (657°). Since the independent observations of separate investigators give, for the difference between the melting-points of Pd and Pt, the values 204°, 207°, and 207°, the melting-point of Pt may be taken as 1755°. T. H. P.

REFERENCES.

401. *Relations between the Maximum Pressures and Densities of Saturated Vapours and Liquids.* **G. Meslin.** (Journ. de Physique, 8. pp. 752–757, Oct., 1909.)—The author derives mathematical relations between (1) the max. pressure π and the specific volume u of a saturated liquid and the magnitudes dv/dt and dp/dt relating to the expansion of the liquid; (2) π, u and the magnitudes dv/dp and dv/dt; (3) the specific volumes, expansions, and compressibilities of the vapour and saturated liquid. Certain consequences of these relations are discussed. T. H. P.

402. *Shape of the Isobars of Water-vapour.* **G. Fontené.** (Journ. de Physique, 8. pp. 275–277, April, 1909.)

SOUND.

403. *Longitudinal Pressure of Sound Waves.* **E. E. Hall.** (Phys. Rev. 28. pp. 385–386, May, 1909. Abstract of paper read before the Amer. Physical Soc.)—The longitudinal pressure of a train of sound waves coming from a vibrating tuning-fork may be readily shown as a lecture-room experiment. A torsion balance is made by a suspension of silk or quartz, the beam being of fine glass tube 10 cm. long with a thin piece of mica 2 or 3 cm. square at one end balanced by soft wax at the other. A mirror in the middle serves to show the deflection. The whole is mounted in a box with tube for the suspension. One side of the box should have a glass window and another covered with loosely-stretched rubber-dam through which a short heavy brass rod projects, its cross-section being equal to the size of the mica vane to which its end is parallel at the distance of 1 or 2 cm. The stem of the vibrating fork is applied to the outer end of the brass rod, which then receives longitudinal vibrations, gives them to the air in the box, and so affects the vane. A König fork of 256 per sec. gave a deflection of 6 to 10 ft. on a wall 20 ft. distant. The spot of light does not move for 2 or 3 seconds. [See also Abstract No. 1254 (1905).] E. H. B.

404. *Motion of Violin Bridge.* **J. W. Giltay** and **M. de Haas.** (Konink. Akad. Wetensch. Amsterdam, Proc. 12. pp. 513–524, Jan. 26, 1910.)—The literature of the physics of bowed instruments is limited and leaves the true nature of the bridge's motion undecided. The present work is an experimental contribution as to the manner in which the vibrations of the strings are transmitted to the belly of the violin by the bridge. The authors fixed a screw-clamp to the bridge in a number of different positions, and noted the changes so produced in the intensity and quality of the tones from the various strings. They also considered with respect to each position of the clamp what vibration of the bridge it might be expected to check. This point was examined by noting the axes about which the bridge's movement of inertia was chiefly increased. Van Schaik had considered that the bridge oscillated about a line parallel to the strings and through the right foot which rests near the sound post. Barton and Penzer, experimenting with a monochord, had found that the bridge moves transverse to the string and also much more in the direction of the length of the strings. [See also Abstract No. 1036 (1907).] This result is confirmed by the work of the present authors, who detected very little motion in the mode contemplated by Van Schaik. It was also shown by experiments with strings electrically maintained by one of known mass and tension, that the violin bridge and belly yield vibrations of the pitch of the fundamental of the string.

E. H. B.

REFERENCE.

405. *Voice Photographs in Medical Practice.* **Marage.** (Comptes Rendus, 150. pp. 232–235, Jan. 24, 1910.)—Describes the manner of taking photographs of the patient's voice vibrations before and after medical treatment for pharyngitis, and maintains that the information thus obtained would afford the practitioner a guide as to the progress of the case. E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

406. *Radiation from Neutral Electric Systems.* **D. F. Comstock.** (Phys. Rev. 28. pp. 377–378, May, 1909. Abstract of paper read before the Amer. Physical Soc.)—The rate of energy radiation from a point-charge moving with not too great velocity varies as (charge × acceleration)². The radiation from two rigidly connected point-charges will interfere, but not entirely annul each other, for, the acceleration changing with the time, the amplitudes of the waves reaching a given point will in general differ, and the resulting wave amplitude will depend on the rate of change of acceleration. Hence the amplitude of the radiation wave from any neutral, rigid, non-rotating electric system involves a series of terms of the form $c_1/V \,.\, da/dt$, $c_2/V^2 \,.\, d^2a/dt^2$, $c_3/V^3 \,.\, d^3a/dt^3$, &c., where a is the acceleration of the system, V the velocity of light, and c_1, c_2, c_3, &c., are constants depending on the structure of the system. Analysis shows c_1 to depend on the electric moment, and c_2 to resemble a moment of inertia in which electric charge takes the place of mass. For $c_1 = 0$, c_2 is independent of the axes, and therefore a fundamental constant of the system, and the corresponding term is shown to be probably the prevailing one in radiation from real atoms, if pure electric systems. The amplitude of the radiation wave is then proportional to d^2a/dt^2, and hence the energy radiated from the atom per sec. is proportional to the square of this, viz., to the eighth power of the velocity, and therefore the fourth power of the absolute temperature, agreeing with Stefan's law. It can be shown on the same basis that the rate of energy radiation from atoms of similar geometric structure moving in the same way, varies as their electromagnetic mass and as the fifth power of any linear dimension.

G. W. de T.

407. *Spontaneous Generation of Electrons in an Elastic Solid Ether.* **A. McAulay.** (Phil. Mag. 19. pp. 129–152, Jan., 1910.)—The mathematical parts of this paper are quaternionic analysis and difficult to further abbreviate. After this introduction the author states his first ether hypothesis, which may be outlined as follows. The general picture presented by recently acquired knowledge of atoms and electrons is accepted, also the attendant hypothesis that the atom is what we know it to be largely because formed of orbitally moving electrons; the view is also accepted that the free ether is stagnant. If free ether is a stagnant isotropic elastic solid, what can be the general nature of those freely mobile electrons? The answer is almost axiomatic. The free ether is a stable form of the solid. By finite straining (supposed small) the stability is left behind. There is a second state, providing for electrons, which may or may not be associated with a second absolute minimum value of the volume potential energy. There is a critical condition such that if the strains in an assigned manner exceed it, the medium, instead of tending to return to the free ether state, tends to deviate still further; and though this critical condition is not one of *absolute* instability, it may be referred to as the unstable state. A contour diagram is given of the hypothetical strain of the ether, and it is pointed out that exceptional singularities may occur concentrated about points, lines, and surfaces. These may be called knots, threads, and webs. Threads and webs inherently tend to shrink. It seems certain, therefore, that they cannot exist permanently, except when projecting from knots. Finally, the suggestion is made that the electrons are the knots connected in systems by threads (or webs) pulling them together. The undoubted shrinking tendencies of webs and threads, and the undoubted attraction of curl to the middle of webs and threads follows from no highly artificial constitution for the solid, but from what can only be called as simple a constitution as it is possible to give. Thus in the light of modern knowledge concerning atoms and electrons the old Fresnel view is revived that the ether is an isotropic elastic solid. Free ether exhibits this solid in a standard state, which is stable for infinitesimal strains; matter exhibits the same solid in a second state, obtained from the first by small finite straining, which is rendered possible by the constitution of the solid. It is assumed that the two states can permanently exist in stable equilibrium for the solid as a whole, or, failing that, that they can exist sub-permanently in an evolved state of balanced motions. E. H. B.

408. *Heat developed during the Absorption of Electricity by Metals.* **O. W. Richardson** and **H. L. Cooke.** (Nature, 82. p. 278, Jan. 6, 1910.)—A consequence of the difference in the value of the potential energy of an electron when outside and when inside a metal is that when electrons possessing negligible kinetic energy pass into a metal an amount of heat should be liberated which is equal in magnitude to the difference in the potential energy for each electron, multiplied by the number of electrons entering the metal. Experiments which have been carried out by the writers show that this effect exists, and is of the expected order of magnitude. The method adopted was to cause the electrons emitted by two hot osmium filaments to flow on to a grid of fine Pt-wire, which acted as a bolometer, and was placed in one arm of a double Wheatstone bridge. The double-bridge arrangement enabled the galvanometer to be balanced for the thermionic current into the bolometer in each experiment. The change in the resistance of the bolometer per unit thermionic current was measured when different voltages were maintained between it and the negative ends of the filaments. The experiments point to the conclusion that there is a liberation of potential energy when the electrons enter the metal, comparable with that which would be acquired by falling through a p.d. of about 8 volts. J. J. S.

409. *Constant of Atomic Vibration and Nature of Dielectric Capacity.* **W. Sutherland.** (Phil. Mag. 19. pp. 1–25, Jan., 1910.)—A theoretical investigation following up the ideas developed previously by the author. The salient features of the paper may be summarised as follows. The central cause of the spectrum of an atom is a special pair of electrons situated within the atom on its electric axis. The atom is electrised, or electrically polarised, because it is formed of constitutive pairs of electrons which have their electric axes similarly directed so as to give the atom electric properties analogous to the magnetic ones of a uniformly magnetised sphere. The internal electric field of the atom corresponds with the external field which produces cohesion. The special electron pair consists of a positive electron which acts as though uniformly distributed through a sphere of radius $R = 0{\cdot}795 \times 10^{-8}$, which is the same for all atoms. This action may be due to the rapid random motion of a small positive electron through this sphere of constant size. The negative electron is situated at distance r along the electric axis of the atom from the centre of the sphere of radius R. As

regards outside action the positive electron may be supposed altogether at the centre of the sphere, so that the special pair of electrons has an electric moment *er* oppositely directed to that of the whole atom which is denoted by *es*. This electric moment *es* produces the external electric field of cohesion, and it produces the internal field in which the special pair of electrons vibrates. The special negative electron is attracted by the positive with a force $(e^2/r^2)(r^3/R^3) = e^2r/R^3$, and comes to rest in the internal field at the distance defined by the equation $r/R^3 = s/a^3$, where a is the radius of the atom. If displaced along r or in any direction at right angles to r the negative electron, of inertia i, oscillates with a frequency $(e^2/R^3i)^{1/2}/2\pi$. Thus the negative electron has three degrees of freedom in which its frequency is the same. Moreover, this frequency is the same for all atoms if R is the same for all, and that is why it is stipulated that R is to be an absolute constant. It is assumed that there is a fundamental period of vibration the same for all atoms, because in the Balmer-Rydberg formula $1/\lambda = n = n_0 - b/(m + w)^2$, the parameter b has nearly the same value for many series of spectral lines in many elements. The frequency bV (V = speed of light) is a fundamental constant of Nature, such that $1/\mathrm{V}b$ might yet furnish a natural unit of time, R being an associated natural unit of length. In the non-metals there is a tendency for *es* to be proportional to a^3, so that if the frequency is constant and R also, then r is nearly constant in the non-metals. In the metals of the Li and Be families *es* is proportional to a, so that r is inversely proportional to a^2, yet the fundamental frequency is constant. By means of the constitutive pairs of electrons and the special pair in the atom a theory of dielectric capacity is reached thus. The electric axes of the pairs in matter free from external electric action are distributed at random as regards their direction. Thus an average direction for a single representative pair when an electric intensity is applied to the matter is that at right angles to the intensity. The average pair of electrons is subjected to a shearing stress by the action of the external electric intensity, so also is the special pair, and also the atom as a whole. If in each case we introduce the corresponding rigidity, we derive the associated strain which gives the whole electric displacement caused by the external electric intensity. In this way is obtained the dielectric capacity of any atom, and formulæ are derived for metals and non-metals. [See also Abstract No. 428 (1908).] **E. H. B.**

410. *Theory of Structure of Electric Fields with Applications to Röntgen Radiation and to Light.* **J. J. Thomson.** (Phil. Mag. 19. pp. 301–313, Feb., 1910.)—The author has previously shown how the phenomena of the electric field can be regarded as the method of working of a mechanical system, the parts of which are the tubes of electric force, which on this view are endowed with mass, momentum, and energy. Using this conception of tubes of electric force, the theory is here put forward that the electric field is made up of a number of discrete units. The properties of the tubes of force are determined by the charge at their ends, hence if that charge is the charge carried by a corpuscle, or a particle in the canal rays, which, as far as we know, is incapable of further subdivision, the corresponding tube of force will be incapable of further subdivision, and will form a natural unit. Now, the question at once arises, Does the tube of force attached to a corpuscle spread out uniformly in all directions, like the lines of force round a charged sphere, or is the tube confined within a cone of small vertical angle? We usually regard the electric field round an electric charge as spreading out uniformly in all directions, so that the force remains unaltered in magnitude as long as we keep at the same distance from the electric charge. We must remember, however, that the charges used in the experiments by which this result has been established are many million times the charge on a corpuscle, and it is evident that when we superpose the fields due to millions of corpuscles the result will be the same whether each individual field is uniformly distributed in all directions or is confined within a small solid angle. Each would give a field uniform in all directions: on the first supposition the field would be continuous, while on the second it would have a structure. We are now, however, able, in kathode rays, to observe the behaviour of particles carrying the indivisible unit, so that the nature of the field round the unit charge is an important subject, and one which we might hope to be able to settle by experiment. The properties of a corpuscle, on the supposition that the electric field around it is uniformly distributed, have been known for some time. In the present paper the author considers what the properties would be if the electric force due to a corpuscle was practically exerted along only one diameter. It is then supposed that the tube of force attached to a corpuscle is a double cone of small vertical angle, so that it is only within this cone that the corpuscle exerts any electric force. There is discontinuity between the electric force inside and outside this cone. To reconcile this with the principle of the Conservation of Energy we may suppose that a finite amount of work is spent or gained when one corpuscle crosses the boundary of a tube of force due to another. On this view the electric field due to a number of corpuscles is a mosaic, as it were, made up of a number of detached fields, the electric field itself, as well as the electric charges in it, being molecular in constitution. The properties of isolated tubes are here assumed the same as those possessed by a tube forming part of a continuous electric field, viz., (1) That the product of the electric force (due to the charge) and the cross-section of the tube is constant and equal to 4π times the charge. (2) That when the tube is moving relatively to axes which are fixed with reference to the physical measuring instrument, there is a magnetic force at each point in the tube which is the vector product of electric force and velocity of the tube. (3) That there is momentum with reference to the same axes throughout the tube equal per unit volume to the vector product of the electric and magnetic forces divided by the square of the speed of light. (4) That if R and H are the resultant electric and magnetic forces at a point in the tube in electrostatic units, and c the speed of light, the energy of the tube per unit volume is $(R^2 + H^2/c^2)/8\pi$. On this basis the following results are obtained. The corpuscle is regarded as a sphere of radius a with charge e, the tube of force being the portion outside the corpuscle of a double cone whose solid angle is ω, and whose vertex is the centre of the corpuscle. Then, the energy in the whole tube at rest, taking the entire double cone, is $\pi e^2/\omega a$. This is greater than if the lines of force were uniformly distributed round it, in the proportion of 2π to ω. For a tube moving with speed u in a direction inclined θ with its axis, there is a magnetic field whose energy is $(u^2/c^2)\sin^2\theta$ times that due to the electrostatic field. Also the expression for the latter needs modification now there is motion. For, when the lines of electric force are in motion, they suffer a compression $q = \sqrt{(1 - u^2/c^2)}$ parallel to the direction of that motion. This diminishes the solid angle to $q(\sin^2\theta + \cos^2\theta 1/q^2)^{3/2}\omega$. Thus the kinetic energy depends on θ, and the motion will not be steady unless θ has the value which makes this energy a maximum. Hence for steady motion $\theta = \pi/2$, so that the axis of the tube, when a small double cone, is always at right angles to the direction in which it is moving, whatever the speed, whereas for lines of force uniformly distributed round a particle at rest, this equatorial distribution is only attained for the speed of light—*i.e.*, for $u=c$. The momentum of the tube for steady motion is found to be parallel to the speed u of the corpuscle, and is expressed by $2\pi ue^2/\omega ac^2q$. Thus the mass of the corpuscle is $2\pi e^2/\omega ac^2q$, which varies inversely as q, just as given by the Principle of Relativity when the lines of force are supposed to be distributed all round the corpuscle. For slowly moving corpuscles the expression for the mass is $2\pi e^2/\omega c^2a$ instead of $2e^2/3c^2a$, as found when the lines of force are supposed to be uniformly distributed. Since $2\pi/\omega$ is a large quantity the value of a founded on the supposition that the lines of force are concentrated in a cone will be much larger than the value calculated on the basis that the lines of force are uniformly distributed. When a moving corpuscle is suddenly stopped in time τ a kink is produced in the tube of force each side of the corpuscle, and the fraction $a/c\tau$ of its energy is radiated away by the travelling of these kinks along the tube. Accelerations of the corpuscle and the consequent radiations are also considered, and it is finally shown that the axis of the tube sets itself at right angles to an impressed magnetic field as well as at right angles to that of its own motion, so that in this case the axis of the tube is determinate.

E. H. B.

411. *New Determination of Electrical Charge by Cloud Method.* **R. A. Millikan.** (Phil. Mag. 19. pp. 209–228, Feb., 1910.)—From a new modification of the cloud method the author finds for the elementary electrical charge, the numbers 4·59, 4·56, 4·64, 4·83, 4·87, and 4·69. These give the simple mean 4·70 or, when *weighted*, the final mean $e=4{\cdot}65\times10^{-10}$. The following other values are noted :—

Planck	$4{\cdot}69\times10^{-10}$	Begeman	$4{\cdot}67\times10^{-10}$
Rutherford and Geiger	$4{\cdot}65\times10^{-10}$	Millikan	$\underline{4{\cdot}65}\times10^{-10}$
Regener	$4{\cdot}79\times10^{-10}$	Mean	$4{\cdot}69\times10^{-10}$

Taking this last mean value, the corresponding value of n (number of molecules per cm.³ of gas at 0° C. and 76 cm. pressure) is $2{\cdot}76\times10^{19}$; that of N (number of molecules in 1 gm.-mol.) is $6{\cdot}18\times10^{23}$; that of $\epsilon(=(3/2)RT/N$, the kinetic energy of agitation in ergs of a molecule at 0° C., 76 cm. pressure) is $2{\cdot}01\times10^{-16}$; that of m (the mass in gm. of an atom of hydrogen) is $1{\cdot}62\times10^{-24}$.

E. H. B.

412. *Notation and Units.* (Deutsch. Phys. Gesell., Verh. 11. 21. pp. 551–560, Nov. 15, 1909. Auschuss für Einheiten und Formelgrössen.)—The notation proposed by the Committee is as follows. Absolute temperature T; Centigrade temperature t or θ. *In alternating currents:* J the effective current in a conductor; E the effective voltage between its terminals; L the mean energy used in the conductor: $S=E/J$, the apparent resistance; but this only holds good so long as inductivity, capacity, and resistance are independent of the current and the e.m.f., *i.e.*, with simple sinusoidals or monophase currents or at most to an approximation with iron magnetic circuits containing air-gaps. Energy-resistance $R=L/S^2$; transverse resistance $B=\sqrt{S^2-R^2}$, which may be divided into inductive reactance and capacity reactance: $J_R=L/E$, current in terms of energy and e.m.f.;

$J_B = \sqrt{J^2 - J_R^2}$, transverse current; $E_R = L/J$, e.m.f. in terms of energy and current; $E_B = \sqrt{E^2 - E_R^2}$, transverse e.m.f.; $c_\phi = L/EJ$, efficiency-factor. In *monophase currents,* current $\propto$ e.m.f.; e.m.f. $e = E \sin \omega t$ produces current $i = J \sin(\omega t - \phi)$; $E_R = JR$; $E_B = JB$; $c_\phi = L/EJ = R/S = \cos\phi$. If the branch have a capacity and an inductance in series, $B = \mathfrak{L}\omega$ (inductive reactance) $-\frac{1}{C\omega}$ (capacity reactance). S, R, and B are independent of current and e.m.f., but depend on the frequency $\nu = \omega/2\pi$; C and ϕ can be computed from B and R. *Polyphase currents,* current $\propto$ e.m.f.:—e.m.f. $e = \sum_n E_n \sin(n\omega t + \chi_n)$ produces current $i = \sum_n J_n \sin(n\omega t + \psi_n)$. Each component sinusoidal e.m.f. produces a corresponding component sinusoidal current; so that the remaining formulæ are analogous to those under simple sinuoidals above; and by summation for all the components we obtain the aggregate values for R, B, S, &c., in polyphase currents; these depend on the frequency and on the resultant wave-form. *Polyphase currents,* current not $\propto$ e.m.f.:—this occurs when iron or a dielectric render resistance, inductivity, and capacity dependent on current and e.m.f.; the proportionalities then fail and are only valid for particular cases. *Equivalent sinusoidal* (replacement monophase current) replacing the actual polyphase current for practical purposes of calculation; J and E the same as those in the polyphase current; frequency = the lowest component frequency; lag ϕ found from $\cos\phi = C_\phi$. General notation; length l; mass m; time t; radius r; diameter d; wave-length λ; volume V; angle, arc, $\alpha, \beta \ldots$; lag ϕ; velocity v; acceleration of gravity g; angular velocity ω; number of revolutions per unit of time n; work, mechanical or electrical, A; efficiency η; pressure per unit of area p; modulus of elasticity E; absolute temperature T; Centigrade temperature t or θ; quantity of heat Q; specific heat c; specific heat at constant pressure c_p; do. at const. volume c_v; coefficient of expansion by heat α; gas-constant per molecular weight R; magnetisation $\mathfrak{J}$; strength of magnetic field $\mathfrak{H}$; magnetic induction $\mathfrak{B}$; magnetic permeability μ; magnetic susceptibility κ; e.m.f. E.; current-strength J; quantity of electricity Q; inductance (coefficient of self-induction) L or $\mathfrak{L}$; electrostatic capacity C. A. D.

413. *Variations observed in Electroscopic Measurements and their Prevention.* **A. S. Russell.** (Phil. Mag. 19. pp. 278-284, Feb., 1910.)—The leaf of a sulphur-bead electroscope which has not been in use for some time is charged negatively, and the rate of discharge of the leaf under the γ-rays from a constant ionising source is measured. The leaf is immediately recharged to the same negative potential and the rate of discharge again measured. This process is continued, and it is found that each successive rate of leak is greater than the preceding until successive chargings give no further increase. The max. rate of leak so obtained is about 20 to 30 per cent. greater than the leak obtained when the leaf is first charged. If the leaf is now charged positively (the absolute value of the potential being the same) the rate of leak is less than that obtained at first with the negatively charged leaf. Again, with successive charging a steady state of max. leak equal to that with negatively charged leaves is after a time obtained. The leak with first charging is found to be the normal leak. This is produced if strong ionisation by an external source precedes charging, and also if weak ionisations act over a correspondingly longer time, *e.g.*, the natural ionisation of the air for 4 or 6 hours. The abnormal effects occur whatever the nature of the electroscope walls or base, no matter what is the nature of the ionising source, and it is the same whether the potential is just great enough to cause saturation or much greater. These effects are found to be due to the presence of a long rod of sulphur—the longer the rod, the more pronounced being the effects—and they are also favoured by a high potential on the leaf. A. E. G.

414. *New Electroscope Phenomenon and its Application to Thunderstorm Electricity.* **W. W. Strong.** (Phys. Zeitschr. 11. pp. 13–14, Jan. 1, 1910.)—Wood and Campbell, the present author, McKeon, and Pacini have found that the ionisation in closed vessels has a daily period. On this account the author concluded that the penetrating rays which bring about a part of this ionisation likewise alter in amount, and that this alteration is very easily explained on the assumption that at least a part of the penetrating rays depends upon the presence of a radio-active product in the air, and that the amount of this alters with the weather [see Abstract No. 684 (1908)]. The double form of Wilson sulphur-bead electroscope used is described. The velocity of the fall of the gold-leaf is greatest about midday, and the variation in the rate of fall is very small when the electroscope is placed in a hole in the earth or in a cellar. It is therefore thought that diffuse sunlight may alter the insulating power of the sulphur, but such is not proved to be the case. On warm days it is found that a large increase in the velocity of fall of the gold-leaf takes place when the electroscope is in a cellar, and the rate of fall only becomes normal after it has been removed from the cellar for several days. A brief explanation of the way in which this phenomenon supports the Wilson-Gerdien theory of thunderstorm electricity is given. A. E. G.

DISCHARGE AND OSCILLATIONS.

415. *Fatigue Effects of Kathode in Discharge Tube.* **R. Whiddington.** (Cambridge Phil. Soc., Proc. 15. pp. 183–188, Nov. 19, 1909.)—Investigation as to the influence of gases occluded in the kathode upon the emitted kathode rays. As the kathode—*e.g.*, carbon kathode—loses gas, the rays, at first of different velocities, lose the faster and more penetrating rays until at last, when the kathode is quite fatigued, the rays are very homogeneous. Running as kathode liberates gas which mere heating cannot. It is impossible to restore the exhausted kathode to its original condition by making it absorb gases (H, O, N, CO_2, CO, or He). The kathode-fall is rather greater (20 to 60 per cent. greater) for new Al kathodes than for those which have run for some time. For heavy kathodes a considerable time was required to reach a steady state; light kathodes reached it immediately, without any gradual fall. Very thin kathodes show no fatigue effect. Query: What is the gas, the loss of which causes the fatigue effect? A. D.

416. *Photoelectric Effect.* **A. Klages.** (Ann. d. Physik, 31. 2. pp. 343–364, Jan. 28, 1910.)—Experiments were made on photoelectric action using fresh surfaces of mercury and tin and zinc amalgams in order that the surface acted upon might be kept clean and chemically unchanged. The substances were placed in a vacuum in order to get rid of the action of gases. It was found that reflection of kathode rays has not really any influence on the photoelectric radiation as shown by investigation of the quantity and velocity distribution curve. The existence of the point of inflection in this curve, found by Lenard, was established with complete prevention of the reflection, contrary to the doubts expressed by Ladenburg and Markau. It was found

that the max. initial velocity was not dependent on the substance exposed to the rays. It appeared besides that the max. quantity is independent of the substance acted on by the rays. The last two results held good for the substances investigated. Whether they hold universally requires further experiment. J. J. S.

417. *Photoelectric Effect of Alkali Metals in Polarised Light and its Dependence upon the Wave-length.* **R. Pohl.** (Deutsch. Phys. Gesell., Verh. 11. 28. pp. 715–722, Dec. 15, 1909.)—The fluid Na-K alloy is used in these experiments. Two different types of tubes are employed, and tables of results obtained with the Nernst and the mercury vapour lamp are given. In the case of one of the tubes a quartz window is fitted, and a series of results obtained when this is used in conjunction with the mercury vapour lamp are given. From these experiments it is concluded that the photoelectric properties of the alkali metals when exposed to the zone of short-waved ultra-violet rays in polarised light, are similar to those of the other metals. [See also Abstract No. 129 (1910).] A. E. G.

418. *Variation in Inertia of the Electron in Kathode Rays as a Function of its Velocity, and the Principle of Relativity.* **C. E. Guye** and **S. Ratnovsky.** (Comptes Rendus, 150. pp. 326–329, Feb. 7, 1910.)—The method of electric and magnetic deviation of the kathode rays is employed, and in order to make the measures as comparable as possible a constant deviation is always used. The experimental results are compared with those obtained by calculation from the formulæ of Lorentz and Abraham, and it is found that while those obtained by the former differ by only 1–2 per cent., those by the latter differ as much as 4 per cent. from the results obtained by experiment. Again, while the deviations when using Lorentz's formula are 16 positive and 11 negative, those obtained from Abraham's show 26 positive and 1 negative. The principle of relativity is found, as in the measurements of Bucherer and Hupka, to be in accord with experiment. A. E. G.

419. *Fatigue of Metals subjected to Röntgen Radiation.* **R. C. Gowdy.** (Phys. Rev. 30. pp. 62–76, Jan., 1910.)—The first measurements of fatigue were made by the method employed by More. The Röntgen radiation is allowed to fall upon two similar plates, and their secondary radiations are measured and compared. If, then, one of these plates, the "standard," be shielded from the radiation, and the other, the "trial" plate, be exposed for a length of time, a second comparison of the radiations may be expected to show any change in sensitiveness of the trial plate, due to its prolonged exposure to the Röntgen rays. Irregularities in the action of the coil and bulb introduce considerable error, but a differential method was devised which nearly eliminated the effect of these. It was found that freshly polished surfaces of Pb, Sn, Ag, and Fe show fatigue in air, while those of Al, Cu, and Zn experience little or no change in their secondary radiation. Oxidised surfaces when tested did not show any fatigue in air. All the metals tried, except Pt and Pd, gave fatigue in ozone, with accompanying change in appearance due to oxidation. All the lower oxides tested showed fatigue in ozone. None of the highest oxides, with the exception of cupric oxide and lead peroxide, shows any change in sensitiveness. Metals not subject to oxidation do not fatigue in ozone. It appears from the results that there is a close relation between the behaviour of the surface when exposed to Röntgen rays and its chemical stability. The theory that fatigue is due to great absorptive power of ozone is evidently not applicable to this case, since it does not account for the absence of fatigue from a chemically stable surface. The results are also against disintegration theories, for particularly in the ozone experiments there were just as many atoms to disintegrate after oxidation as before. If a density law of absorption holds, the oxides would probably have less absorbing power than the metal itself, and the decrease in radiation cannot be accounted for by assuming increased absorption of the radiation coming from the body of the metal. This limits the secondary radiation mainly to a surface effect. The explanation of fatigue upon a basis of chemical change would lead to the expectation that the more stable a surface the less the fatigue. This order is followed without exception in the results obtained. J. J. S.

420. *Electrical Effect of the Ultra-violet Spectrum.* **E. W. B. Gill.** (Phil. Mag. 19. pp. 290–300, Feb., 1910.)—The present investigation was undertaken in order to ascertain the relative powers of each part of the ultra-violet spectrum for setting free negative ions. The source of light used was an oscillatory electrical discharge passed between two Al electrodes; the length of the spark-gap was 4 mm., and the terminals were about 1 mm. in diam. The spark-gap was connected to the secondary of an 8-in. coil in parallel with a Leyden jar. The current through the primary was about 8 amps., and a hammer interrupter was used. Quartz lenses and prism were used to produce the spectrum. A curve is drawn in which the ions given off are plotted against the refractive indices of the incident light. By this curve it is seen that the electrical effect is just beginning about the middle of the visible spectrum and increases up to a first maximum for refractive index $n = 1{\cdot}66$, sinks to a minimum at 1·67, and reaches a second maximum for $n = 1{\cdot}68$, rapidly decreasing after that. It seems likely that the electrical minimum at $n = 1{\cdot}67$ is coincident with the absorption band in quartz, in which case the statement that quartz is opaque to rays less than 185 $\mu\mu$ in wave-length is erroneous, for the second maximum which is always well marked is beyond this limit. It is also of interest to find that an electrical effect—2 per cent. of the maximum—occurs in the visible spectrum for light of refractive indices between $n = 1{\cdot}54$ and $n = 1{\cdot}56$. A. E. G.

421. *Emission of Electric Charges by the Alkali Metals.* **L. Dunoyer.** (Comptes Rendus, 150. pp. 335–338, Feb. 7, 1910.)—J. J. Thomson described an experiment [Abstract No. 2245 (1905)] in which rubidium or the liquid Na-K alloy gave out negative corpuscles even in darkness. These observations have now been confirmed, but a different interpretation of the phenomenon is offered. The experiments described seem to make it appear that the effects observed when the substances are kept in the dark may be due to the action upon the metal of equilibrium radiations existing at the ordinary temperature in the interior of the black body in which the metal is placed. This renders unnecessary the hypothesis of J. J. Thomson that the effect is due to a spontaneous explosion of the atoms analogous to that which takes place in the case of the radio-active substances. It is proposed to repeat the experiments at very low temperatures. A. E. G.

422. *Condensation of Vapours on Surfaces with Kathodic Deposits.* **L. Houllevigue.** (Journ. de Physique, 8. pp. 908–914, Dec., 1909. Paper read before the Soc. franç. de Physique.)—When vapour condenses on a surface, the drops are largest at those parts of the surface where they are least numerous;

but the mass condensed per unit of surface is nearly constant. The position of the attracting centres may be determined by enumeration of the drops. Exposure of a glass plate to kathode rays for a few seconds forms an attracting surface the extent of which can be made evident by a process analogous to photographic development, the surface being exposed to the action of mercury vapour at 150° until the "image" is brought out. An experiment is described by means of which it is concluded that the attracting centres are formed by the deposition of particles of the kathode, and are not due to the corpuscles forming the kathode rays. To determine the dimensions of the particles shot off by the kathode, it is assumed that each one forms an attracting centre and gives rise to one drop of liquid. Also if, during the same experiment, two regions on the glass plate are exposed, one during a time t, short enough for the number of drops N per $mm.^2$ to be counted, and the other during a time T, long enough for a measurable thickness of e mm. to be deposited, then v the volume of the particle may be calculated from $NvT/t = e$. The experimental arrangement is described by which this is carried out, using a silver kathode, and the resulting numbers for v are 7, 4·3 and $7{\cdot}9 \times 10^{-18}$ $mm.^3$. If the mass of a silver molecule be taken as 8×10^{-19} mgm. each particle of silver projected by the kathode contains twenty million molecules. If the particles are supposed cubical, their length of side is about 80 $\mu\mu$. G. E. A.

423. *Absorption of Kathode Rays of Different Velocity by Helium.* **J. Robinson.** (Phys. Zeitschr. 11. pp. 11–18, Jan. 1, 1910. Translation.)—Lenard and Robinson have both previously found that with a diminution of the velocity of the rays their absorption by a gas increases until, in any particular gas, the highest absorption is reached with a certain definite small velocity. After this any further decrease in the velocity is not accompanied by a change in the absorption. Both observers have likewise found that hydrogen behaves in an abnormal manner. The limiting value of the velocity in this gas is suddenly reached, and is greater than in the other gases which have been used. In the present research the kathode rays are generated by the action of ultra-violet light upon a zinc electrode, and their velocity is varied by charging up this electrode to different potentials. A method is described by which the helium can be introduced into the tube without loss. Curves are given to illustrate the absorption in relation to velocity in helium as compared with that in hydrogen and nitrogen. These show that helium behaves similar to hydrogen in so far as the increase of absorption with diminution of velocity of the rays is concerned, but the increase of absorption is slower, and the slow increase continues for much smaller velocities than in the other gases. A. E. G.

424. *Dielectric Cohesion of Neon.* **E. Bouty.** (Comptes Rendus, 150. pp. 149–150, Jan. 17, 1910.)—Though the molecular weight of neon is between that of helium and argon, its dielectric cohesion is less than that of He, and is therefore the lowest known so far; it is 7·6 (He 18·3, air 435). Discharges pass through it so readily that the small p.d. produced by passing it from one vessel to another is sufficient to make it glow, and in pumping operations it at once begins to glow like fire. A. D.

425. *Carriers of Electricity in Gases.* **A. Becker.** (Ann. d. Physik, 31. 1. pp. 98–126, Dec. 30, 1909.)—An account of a continuation of previous experiments [see Abstract No. 1749 (1909)] with improvements in details. Foreign influences are guarded against and the result is an exact demonstration of a new case of the simultaneous existence of very various motions amongst the carriers of electricity in an electric field. Observations were made on the process of formation of carriers and the change of the constitution of these with time. The bearing of the experiments on the formation of complexes of gas molecules through the action of the forces of attraction due to the electric charges of the carriers is pointed out. The existence of carriers with various velocities in the case of the conductivity produced in gases through falling mercury is clearly established, and the cause of this variety of motion is seen to be the various sizes of the carriers. J. J. S.

426. *Kathode Region.* **J. A. Orange.** (Cambridge Phil. Soc., Proc. 15, pp. 217–232, Nov. 19, 1909.)—The paths of the kathode rays are traced from the luminosity of the rays themselves, instead of from the phosphorescent effects produced by them; photographs are given. The conformations of luminosity are analogous to caustics. The problems involved are: to account for the directions of the constituent straight rays, and to account for the occurrence of luminosity of the rays after, and only after, they have passed through the kathodic interspace. These are discussed. There is much ionisation (and hence luminosity) in the interspace. The positive electric charge is abundant near surfaces of kathodes, the negative accumulated about the medium plane of the interspace. This last must be postulated in order to account for the considerable divergence of the oblique ray sheets and their peculiar curvature. Differences between sheets at higher and at lower pressures are traced out and discussed. A. D.

427. *Distribution of Röntgen Rays from a Focus Bulb.* **G. W. C. Kaye.** (Roy. Soc., Proc. Ser. A. 83. pp. 189–194, Jan. 7, 1910.)—This paper contains an account of some preliminary experiments on the distribution of the Röntgen rays under conditions similar to those which obtain in a modern focus bulb. In such tubes the kathode rays are focussed on an antikathode inclined at 45° to the beam of kathode rays. The disadvantages of this are: the obliquity of the antikathode tends to increase the area of emission of the Röntgen rays, and, in the majority of cases, it is impossible entirely to suppress with a coil-driven tube the harmful reverse currents at "make"; then the kathode rays which during this inverse phase proceed from the antikathode, impinge on the glass and greatly increase the danger of a spark piercing the tube. It appears from these experiments that the hardness and intensity of the Röntgen rays, in the most favourable direction in each case, are over a very considerable range almost independent of the obliquity of the Pt antikathode. In a few cases the condition of normal incidence gives the most advantageous results, but the superiority is slight. The fluorescence of the bulb, which is due to the secondary kathode rays from the antikathode, increases very markedly as the deviation from normal incidence increases, but the Röntgen rays do not show any corresponding order of variation. The 45° position thus enjoys no advantage over any other. The ideal Röntgen-ray bulb would appear to have a concave Al or, better, Ta kathode, (cooled in some way) directly facing, and parallel to a heavy bowl or trough-shaped Ta antikathode. A. E. G.

428. *Magnetic Rotation of the Discharge of the Induction Coil.* **G. Accolla.** (Accad. Gioenia, Boll. 7. 2a. 1909. N. Cimento, 18. pp. 443–445, Nov.–Dec., 1909.)—The discharge is caused to pass between the edge of a brass ring and a zinc plate, the pole of an electromagnet which traverses the middle of the plate being situated between the two. Five experiments are recorded. (1) With air pressure above 78 mm. of mercury and discharge passing from ring to base, the discharge rotates in a positive direction round the pole when this is N., the discharge being seen from above. (2) With pressures between 78 mm. and 60 mm. two paths of the discharge are present, one for the break of the coil, the new one for the make: the magnetic field causes them to rotate in opposite directions. (3) Between 60 mm. and 55 mm. the magnetic field does not produce any rotation. (4) From 55 mm. to 11 mm. pressure the two discharges rotate together, the direction being opposite to that of case (1), *i.e.*, in the direction of the "make" discharge of case (2). (5) For pressures below 11 mm. there is no rotation. The nature of the metal composing the electrodes does not appear to affect the result. S. G. S.

429. *Slow Oscillatory Discharge of a Condenser of* 1000 *Microfarads Capacity.* **O. Martienssen.** (Deutsch. Phys. Gesell., Verh. 12. 1. pp. 2–4, Jan. 15, 1910.) —A description of a demonstration of the oscillatory discharge of a huge condenser, built up of 500 2-mfd. capacities in parallel, through a self-induction of 1000 henries and 50 ohms resistance. The period of oscillation, therefore, is 6·3 sec. A continuous-current ammeter in the circuit follows this slow oscillation, and its pointer indicates by its motion 5 complete oscillations before the discharge is over. T. P. B.

430. *Bending of Electric Waves round the Earth.* **W. Nicholson.** (Phil. Mag. 19. pp. 276–278, Feb., 1910.)—An as yet unpublished investigation by the author in which an estimate is obtained of the intensity to be expected from theory, caused by an oscillator placed on the surface of the earth, regarded as a sphere of infinite conductivity, indicates two errors, one of which has been previously pointed out, in Poincaré's analytical treatment of the same problem [see Abstract No. 888 (1909)], and these errors entirely vitiate the conclusion. The treatment is formally, though not in detail, identical with that of the author, who finds that, for points not close to the region of geometrical shadow, the important harmonics in the expansions used are those containing Bessel functions whose order and argument are not nearly equal, though of the same order of magnitude. The first approximation to the final sum gives, as required by physical needs, the effect of the sphere regarded as a plane reflector. On the confines of the geometrical shadow, within a cone of small angle, cutting off but a small portion of terrestrial surface near the oscillator, diffraction bands are found, in accord with expectation, and these arise ultimately from terms, now important, in which argument and order *are* nearly equal. Within the shadow, beyond the extreme generators of the cone, the extinction is very complete. The harmonics of high order are found to be so disposed as to neutralise one another to a remarkable extent, and the intensity of the refracted light, at a distance of a few thousand miles round the surface, sinks to a minute fraction of its value in the absence of the sphere. It is therefore improbable that the observed effect can be due to diffraction unassisted by reflection from an ionised layer in the upper atmosphere, or by some other cause. The use of directive oscillators is found in practice to increase the effect, and Sommerfeld has shown that the earth's finite conductivity may be sufficient [see Abstract No. 181B (1909)]. G. W. DE T.

431. *Damping of Electric Oscillations with the Spark in Different Gases.* **C. Richter.** (Phys. Zeitschr. 10. pp. 703–707, Oct. 15, 1909. Abstract of Dissertation, Halle.)—An account of experiments suggested by K. E. F. Schmidt, on the influence of the gaseous medium in which the sparks take place upon the damping of the oscillations obtained. A resonance transformer was employed to charge up a capacity of 8000 cm., care being taken not to overload the condenser and to avoid all other losses as far as possible. The oscillations set up were passed to an oscillatory circuit coupled inductively to the first circuit, and were measured by thermo-element in a tertiary measuring circuit. The gases tried were hydrogen, coal gas, nitrogen, oxygen, and CO_2, as well as air. With hydrogen results were not obtainable under a spark-length of 8 mm., but for all the other gases the spark-length ranged between 2 and 10 mm. The curves plotted relating damping with spark-length are very similar for all the gases except hydrogen, the order being (commencing with the lowest damping) oxygen, air, CO_2, nitrogen, coal gas. The damping for air, for instance, ranged from 0·185 for 2 mm., down to 0·142 for 10 mm. spark-length; that for hydrogen from 0·395 at 8 mm., to 0·267 at 15 mm. spark-length. From these values the damping (0·05) of the measuring circuit has to be deducted. The following table gives the values obtained by the author for air, the values obtained by Rempp, Eichhoff, and v. Traubenberg being given for comparison :—

Spark-length.	Rempp. C = 6174 cm.	Eichhoff. C = 3000 cm.	v. Traubenberg. C = 8000 cm.	Richter. C = 8000 cm.
2 mm.	0·119	0·148	0·130	0·137
3	0·090	—	0·100	0·121
4	—	0·128	0·080	0·109
5	0·078	—	0·075	0·102
6	—	0·103	0·070	0·097
7	0·081	—	0·065	0·095
8		0·108	0·063	0·093
9	—	—	0·062	0·091
10	0·094	0·113	0·061	0·090

L. H. W.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

432. *Electrical and Optical Properties of Metallic Selenium.* **A. H. Pfund.** (Phys. Rev. 28. pp. 324–336, May, 1909.)—The sensibility curve expressing the variations of electrical resistance with wave-length of incident energy was redetermined by a method similar to that previously employed [see Abstract No. 363 (1904)]. Comparison with the corresponding reflection and absorption curves showed no marked maxima or minima in the latter near 700 $\mu\mu$ where the sensibility curve attains its maximum. The optical properties by themselves, therefore, fail to account for the sensibility maximum. The author therefore attributes the effect of light on metallic selenium to the expulsion of additional free electrons by resonance set up within the atom. [This explanation has been suggested by Nagaoka, Phil. Mag. 7. p. 455, 1904.] As the reflecting power does not suffer marked changes, the conductivity should increase continuously with the absorption, on this hypothesis, since resonance and absorption go together. This is not the case, but J. J. Thomson has shown that the observed rapid increase in the resistance of thin metallic films below a certain critical thickness, varying with the nature of the metal and the method employed in producing the films, may be accounted for by assuming that the change occurs when the thickness of film becomes less than the mean free path of the conducting electrons within the metal. Now the absorption curve shows that the incident energy is largely absorbed in a film of a thickness of the order of the critical thickness, viz., about 10^{-6} cm. Moreover, the sensitiveness to light shows that the conductivity of the surface film, of infinitesimal thickness in comparison with that of the selenium layer, which was about 0·01 mm., must be comparatively high, so that the circumstances are comparable with those of a thin metallic film deposited on glass. Now, beginning in the infra-red, where the depth of penetration of radiation is greater than the critical thickness, the conductivity increases rapidly with the absorption, but in the region in the vicinity of $\lambda = 700\,\mu\mu$, where the absorption increases very rapidly, the depth of penetration, and hence the thickness of current-carrying layer, becomes equal to, and then less than, the critical thickness, assuming the light to be effective only down to a certain minimum amplitude, below which the resonance would be insufficient to expel electrons from the atom. It is just in this region that the enormous decrease in conductivity with thickness makes itself felt, and not only neutralises the effects due to absorption, but actually causes a sharp drop in conductivity. If this explanation be correct, and the wave-length for max. sensibility be a function of the depth of penetration, then, as the intensity, and consequently the penetration, is increased, the maximum point should shift in the direction of decreasing wave-length. Experiment showed this to be the case. G. W. de T.

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433. *Increase of Conductivity of Liquid Dielectrics by α-Rays.* **H. Greinacher.** (Phys. Zeitschr. 10. pp. 986–997, Dec. 15, 1909.)—Under the influence of the α-rays, paraffin oil and light petroleum exhibit an increase of conductivity, showing that positive rays are also able to ionise liquid dielectrics. The increase in conductivity is appreciably independent of the direction of the current, so that the mobilities of the positive and negative ions produced are practically equal. With paraffin oil, the current at first increases almost proportionally to the square of the p.d., but at higher voltages it increases less rapidly than the p.d.; with light petroleum, only the latter portion of the curve is observed. At higher voltages, increase of the conductivity ceases; with light petroleum this is the case at 400 volts per cm., but with paraffin oil it occurs at beyond 10,000 volts per cm. In the slow saturation observed the effect resembles the ionisation current produced in air by the α-rays. With paraffin oil the final increased value of the conductivity is not attained instantaneously, but only after several minutes, the approach to this final value being at first slow, and subsequently more rapid; this phenomenon is only observed with weak electric fields and with a large distance (1 mm.) between the plates, and it is probably due to the slow establishment of the final distribution of ions between the electrodes. In the case of paraffin oil, the increase of the conductivity disappears only some minutes after the radiation ceases when weak electric fields are employed, but with strong fields the diminution of the conductivity is almost instantaneous; with light petroleum, the effect diminishes rapidly in all cases. On complete absorption, an α-particle produces in light petroleum some 2000 times fewer, and in paraffin oil some 1000 fewer ions than in air. T. H. P.

434. *Electrical Properties of Aluminium-Copper Alloys.* **W. Broniewski.** (Comptes Rendus, 149. pp. 853–855, Nov. 15, 1909. Ind. Élect. 18. p. 548,

Dec. 10, 1909. Abstract.)—The electrical properties of the Al-Cu alloys have hitherto only been investigated within narrow limits, not extending beyond an addition of 12 per cent. of either metal to the other, probably owing to the brittleness of the alloys of the Al-rich alloys. The author's investigation covers the whole range from 100 per cent. Al to 100 per cent. Cu, the alloys being in the form of rods 12–15 cm. long and 5 mm. in diam. The resistivity was measured for the range 0–100° C. by means of a Thomson bridge. The thermo-e.m.f. is taken with reference to copper. The temperature-coefficient is also determined and the e.m.f. of dissolution with reference to a carbon electrode depolarised by MnO_2 and immersed in sat. ammonium chloride solution. The results are set forth in a table and in curves, the former being reproduced in part :—

Cu Per Cent. by Volume.	Conductivity at 0°.		Temp. Coefft. Annealed.	Thermo-e.m.f at 0°. Microvolts per 1 deg. C.
	Quenched.	Annealed.		
0	38·5	40·0	0·00425	2·95
1·18	23·5	31·0	0·00375	2·59
2·78	22·1	27·9	0·00348	2·51
6·41	18·9	25·4	0·00325	2·61
10·6	18·5	23·2	0·00304	2·79
16·3	16·7	19·7	0·00268	2·85
23·1	(11·9)	16·5	0·00252	3·08
31·6	12·4	14·1	0·00222	1·44
37·9	11·5	13·0	0·00211	— 0·77
41·7	9·14	12·1	0·00208	— 0·92
47·3	6·82	9·8	0·00147	— 0·60
50·1	6·58	8·61	0·00118	0·16
52·6	3·50	3·56	0·00080	— 3·76
54·4	3·54	3·46	0·00065	— 3·92
58·8	6·45	4·72	0·00070	— 3·19
64·7	8·35	6·33	0·00091	5·20
68·3	13·4	7·80	0·00040	4·24
73·3	6·85	8·47	0·00113	1·10
80·3	7·52	9·22	0·00097	0·82
86·0	9·62	10·05	0·00081	0·78
94·0	17·5	17·1	0·00085	0·64
100	64·0	65·0	0·00428	0

The minimum of conductivity (between 52·6 and 54·4 per cent. Cu) is very strongly marked, and coincides with the minimum of the temperature-coefficient curve. From the curve of e.m.f of dissolution the existence of the compounds Al_3Cu, AlCu, Al_2Cu_3, and $AlCu_3$ is indicated. No sign of Al_2Cu is found. [See also Abstract No. 469 (1910).] L. H. W.

435. *Absorption of Energy by a Dielectric.* **F. Beaulard and L. Maury.** (Journ. de Physique, 9. pp. 39–44, Jan., 1910.)—The values obtained for the dielectric coefficient of insulating materials by different experimenters differ according to the method employed. Following Drude the authors distinguish between the true coefficient and the apparent coefficient. The true coefficient is found by experiments on the propagation of electricity by wires, the apparent coefficient by experiments on the propagation of electricity through the medium itself. In the first case the wires are suspended in air and then placed in the dielectric medium, the velocity of

propagation being measured in the two cases. In the air we have $\lambda = VT$ and in the dielectric $\lambda_1 = V_1T$ and thus $n = \lambda/\lambda_1 = V/V_1$, where n is the true refractive index for the medium. If $\epsilon =$ the apparent dielectric coefficient, then $\epsilon = n^2 (1 - \chi^2)$ where n^2 is the true dielectric coefficient and χ the absorption constant. The statical method of measuring ϵ gives its value for infinitely long waves. By hanging a quartz ellipsoid, containing the liquid to be examined, in a Hertzian field and noticing the deflection produced the authors find the following values of ϵ for mixtures of alcohol and water.

Concentration, per cent.	Dielectric Coefficient.	
	$\lambda = 35$ m.	$\lambda = 12$ m.
100	4·565	8·701
99	4·876	8·684
98	4·849	8·628
97	4·775	3·825
96	5·058	8·901
95	4·648	4·969
90	4·581	8·700
85	4·812	8·486
80	4·152	8·505
70	6·120	8·892
60	5·761	8·908
50	5·144	8·162
40	4·562	8·629
30	4·501	8·588
15	4·956	3·456
0	4·418	8·592

Giving to n^2 its statical value, we have—

	Alcohol.	Water.
$\lambda = 35$ m.	$\chi = 0·907$	$\chi = 0·972$
$\lambda = 12$ m.	$\chi = 0·923$	$\chi = 0·977$

The variations in the value of the dielectric coefficient are remarkable.

A. R.

436. *Electrochemical Equivalent of Silver.* **F. Laporte and P. de la Gorce.** (Comptes Rendus, 150. pp. 278–280, Jan. 31, 1910.)—The values for the electrochemical equivalent of silver obtained in 1907 at the National Physical Laboratory [see Abstract No. 868 (1908)], in 1908 at the Laboratoire central d'Électricité [Abstract No. 137 (1909)] and in 1909 at the Reichsanstalt [Abstract No. 287 (1909)] are respectively 1·11827, 1·11868, and 1·11818 mgm. per coulomb, the results being expressed in terms of the coulomb as realised at the National Physical Laboratory. The differences led to further investigations at the *Laboratoire central* which show that the silver nitrate used in 1908 was probably impure. With four other carefully prepared samples the values 1·11827, 1·11831, 1·11827, and 1·11832 were obtained, and 1·11825 was obtained with a pure commercial sample. The mean of the first 4 of these values is 1·11829—a value in very good agreement with the numbers 1·11827 and 1·11818 obtained in England and Germany, respectively.

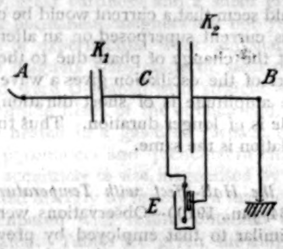
F. E. S.

437. *Elimination of Electric Directive Couples in the Quadrant Electrometer.* **L. Décombe.** (Comptes Rendus, 150. pp. 164–167, Jan. 17, 1910.)—By rotating

the torsion head of the needle through a given angle α, to reduce the angle of deflection of the needle to zero, the equation of the electrometer is simplified, becoming of the form: $C\alpha = F(V_1, V_2, V)$, where C is the torsion coefficient and V_1, V_2, and V are the three potentials in the electrometer. The effect of the contact e.m.f. between the quadrants, the needle and the earth is also considered. No experimental results are given. G. E. A.

438. *New Magnetic Inductors for High Frequencies.* **R. Hartmann-Kempf.** (Phys. Zeitschr. 10. pp. 1018–1022, Dec. 15, 1909.)—A description is given of some high-frequency machines which are made by Hartmann and Braun. The peculiarity in construction lies chiefly in the form of the armature poles. Thus in the smallest machine there are three armature coils, and the field-magnet system consists of three separate horseshoe magnets. Machines are also built with 12, 24, and 48 poles, and generally there are only half as many armature coils as pole-changes per revolution. The power of the 48-pole machine at 100 ∿ amounts to 100 watts. Full particulars are given of a double inductor having two separate current circuits giving different frequencies. Such inductors are useful for producing quite pure simple tones and also combination tones. Thus the 24-pole machine can attain a speed of 3000 revs. per min., and will thus give in a telephone a note of frequency 600. W. C. S. P.

439. *Simple Arrangement for Measuring High Electrostatic Tensions and for Comparison of Capacities.* **M. Dieckmann.** (Phys. Zeitschr. 11. pp. 14–16, Jan. 1, 1910.)—The principles involved can be illustrated as follows: Suppose a large p.d. exists between the two points A and B, and, for the sake of simplicity, let B be to earth. Between A and B are two known capacities K_1 and K_2 connected in series. E is a Lutz-Edelmann string electrometer, the string of which is connected to C. The capacity of the electrometer is supposed small compared with that of K_2, or included with it. Then if V_1 and V_2 are the potentials of A and C compared with B (earth), $V_1 = V_2(K_1 + K_2)/K_1$. The condensers used are Leyden jars, and a Kirchhoff balance is employed to check the voltages obtained. The result of one experiment is: Voltage by above method, 1928; as indicated by balance, 1910 volts. A. E. G.



440. *"The Phasograph." New Instrument for Studying Alternating Currents.* **M. Siegbahn.** (Phys. Zeitschr. 10. pp. 1017–1018, Dec. 15, 1909.)—The apparatus consists essentially of two thin silver wires arranged perpendicular to each other in the form of a cross, and having attached at the crossing

point, a small mirror. By means of electromagnets with special pole-pieces, four magnetic fields are produced near the crossing point. If a current is passed through one of the wires, it causes the mirror to be rotated about the perpendicular wire. If currents are passed through the two wires, the motion of a spot of light obtained by reflection from the mirror will depend on the phase relations of the currents, so that the apparatus is suitable for demonstrating the phase-shifting in inductance and capacity, &c.

W. C. S. P.

ALTERNATING CURRENTS AND MAGNETISM.

441. *Transforming Ratio and Phase Relations in Transformers.* **E. B. Rosa** and **M. G. Lloyd.** (Bureau of Standards, Bull. 6. pp. 1–30, Oct., 1909.)—Particulars are given of the methods of measurement of the ratio of transformation, and of the phase relations, in use at the Bureau of Standards, Washington. It is shown theoretically and by experimental results that the ratio of transformation is little affected by variation of voltage or moderate variation of frequency and wave-form. Also that the phase-angle under normal conditions is so nearly zero that for most purposes the discrepancy is negligible. When used with wattmeters on low power-factors, however, the angle should be determined.

F. E. S.

442. *Transformation of Alternating Current into Continuous.* **H. Barkhausen.** (Deutsch. Phys. Gesell., Verh. 11. 23. pp. 711–714, Dec. 15, 1909. Phys. Zeitschr. 9. pp. 130–132, Feb. 15, 1910.)—The author had already shown that a periodically varying self-induction alone *cannot* give rise to a continuous-current component from a pure alternating e.m.f. He here discusses a case which, it would appear, might contradict this. If the self-induction of a circuit is small in the first half of an oscillation and large in the second half, it would seem that a current would be obtained, which would consist of a continuous current superposed on an alternating one. But the author points out that the change of phase due to the increased self-induction in the second part of the oscillation gives a wave of such a form that the first part of large amplitude is of short duration, whereas the second part of small amplitude is of longer duration. Thus the energy expended in both parts of the oscillation is the same.

T. P. B.

443. *Variation of the Hall-effect with Temperature.* **A. W. Smith.** (Phys. Rev. 30. pp. 1–34, Jan., 1910.)—Observations were made on the Hall-effect by a method similar to that employed by previous observers; both non-magnetic and magnetic metals were investigated. The chief results obtained are as follows: (1) The temperature-coefficient of the Hall-effect in Au, Zn, Pt, Hg, and Al has been determined with certainty, and it has been found that, with the exception of Al, there is in each of these cases a decrease in the effect as the temperature is raised from —190° to about 22°. In the case of Al there is an increase instead of a decrease. (2) The Hall e.m.f. in each of these metals at the temperature of liquid air has been found to be proportional to the magnetic field. (3) The Hall-effect in silicon has been found to have sometimes the direction of the effect in iron and sometimes the direction of the effect in bismuth; the purer specimens gave the effect in the direction of that in iron. (4) A reversal of the thermo-e.m.f. in Si has been found to be associated with a reversal of the Hall-effect. (5)

The Hall e.m.f. in Si has been shown to be proportional to the magnetic field. (6) The relation between the Hall e.m.f. and the magnetic field has been examined in Fe, Ni, and Co for a number of temperatures between −190° and 1100° C. For a given magnetic field the Hall-effect in these metals has been found to increase with rising temperature until the critical temperature of the metal in question has been reached. The rate of increase becomes the greater the nearer the critical temperature is approached. In passing the critical temperature the effect sinks rapidly to a small fraction of its original value, and then in the case of Fe and Ni, and probably in Co, decreases slowly with further rise of temperature. (7) In the magnetic metals, for any particular temperature the Hall e.m.f. is proportional to the magnetic field until the max. intensity of magnetisation in the plate has been reached. Then the curves showing the relation between the Hall e.m.f. and the magnetic fields are nearly parallel to the axis of magnetic fields. (8) With increasing temperature the fields necessary to produce saturation become less in the case of Ni and Fe. In Co, however, the fields for saturation become greater with rising temperature until 800° is reached, and with further rise of temperature the fields for saturation become less. (9) In Ni, Fe, and Co at temperatures a few degrees above the critical temperature, the Hall e.m.f. is proportioned to the magnetic field over its range in these experiments. (10) It is considered that the explanation of Thomson for the reversal of the Hall-effect in Fe is improbable in view of the fact that the effect in Fe does not reverse sign at temperatures above the critical temperature when it has lost nearly all its magnetic properties. J. J. S.

444. *Magnet Steel and Permanent Magnetism.* **G. Mars.** (Stahl. u. Eisen, Oct. 27 and Nov. 10, 1909. Abstracts in Electrical World, 55. pp. 163–165, Jan. 20, 1910. Elektrotechnik u. Maschinenbau, 28. p. 168, Feb. 20, 1910.)—Material for permanent magnets should possess great hysteresis, resulting in the desired retentivity, great hardness, and a small grain. The question as to the best material for permanent magnets has not yet been settled. This paper contains results of experimental works on magnets made of various classes of steel. The magnets were made of steel of rectangular section, 20 mm. × 10 mm., and were U-shaped with straight legs. The total length was 125 mm. and the inside diam. of the circular end, 45 mm. For hardening, the magnets were heated in a gas-fired furnace, the temperature being controlled by suitable pyrometers and quenched in either water or oil. The magnets were ground accurately to size, magnetised by stroking with a strong electromagnet and tested directly by means of a magnetometer. The results so obtained were compared with results obtained 8 days later and the percentage loss calculated. Tables are given showing results obtained with ordinary carbon steels, tungsten steels, chromium steels, chromium-tungsten steels, and special steels. Chemical analyses and results of the Brinell ball test for hardness are also given. With carbon steels the max. retentivity is shown at 0·97 per cent. carbon, and with increasing carbon beyond this, it falls considerably; this is different to results obtained by Mme. Curie, who found a max. retentivity with 1·2 per cent. carbon. With tungsten steels, which are usually used for permanent magnets, the max. retentivity is found with about 0·6 per cent. carbon and 5·0 per cent. tungsten. Chromium has a similar effect to tungsten. The chrome-tungsten steels are particularly interesting and molybdenum steels are of undoubted value, although cheaper magnets can be made by using tungsten or chromium, or both together. The following conclusions have been arrived at from the results of the research: (1) Steel for permanent magnets has the opposite properties, electrotechnically and metallographically to soft dynamo material. (2) The greatest retentivity of the ordinary carbon steels is shown at the eutectoid carbon percentage. The smaller retentivity of steels with less carbon is due to their lesser hardness; with more carbon because of there being less free iron. (3) The greater strength of the special-steel magnets is due to the existence of more free iron in them with equal hardness. (4) For great retentivity, it is necessary that the steel be glass-hard, of very small structure and contain as much free iron as possible. (5) The steel with about 0·6 per cent. C and 0·5 per cent. W, shows the highest retentivity when quenched from a temperature of 930–950° C. C. O. B.

445. *Magnetic Measurements with Platinum Metals and Monoclinic Crystals.* **W. Finke.** (Ann. d. Physik, 31. 1. pp. 149–168, Dec. 30, 1909. Extract from Dissertation, Göttingen.)—A continuation of the work of Voigt and Kinoshita [Abstract No. 1914 (1907)], in which a quantitative measurement of the magnetic properties of the Pt metals and several monoclinic crystals is made, the method employed being the same as formerly. A theory of the measurement of susceptibility in monoclinic crystals is given. For the metals the values of $K \times 10^6$ found were: Pt, 22·6; Pd, 66·26; Ir, 4·89; Rh, 12·58. Crystals of iron, nickel, and cobalt salts, and augite, hornblende, epidote, adular and cane sugar were also investigated. In these there is a considerable difference in the lengths of the chief magnetic axes, with the exception of epidote. G. E. A.

446. *Magnetic and Electric Properties of Iron-Nickel Alloys.* **C. F. Burgess and J. Aston.** (Metallurgical and Chemical Engin. 8. pp. 23–26, Jan., 1910.) —Tests are described on a series of alloys prepared by melting together electrolytic iron and nickel in magnesia crucibles in an electric resistor furnace. The ingots, weighing about 1 lb., were afterwards forged and machined to size, the specimens for the magnetic tests being 20 cm. long by 1 cm. diam. The tests were carried out on an Esterline permeameter and were made with the material in four different conditions, viz., as forged, annealed at 675°, annealed at 1000°, and quenched in cold water at 900° C. With less than 2 per cent. Ni the alloys are little inferior in quality to pure iron. With increase of Ni, however, the permeability rapidly falls off, and alloys with 25–30 per cent. Ni are completely non-magnetic. Further addition of Ni improves the quality to a maximum at about 50 per cent. The annealing results in a general improvement which is most marked in the case of low fields. Fifty per cent. Ni-Fe is for low fields much more magnetic than pure iron. Quenching makes little change except in the case of alloys containing 10–20 per cent. Ni, which are thereby considerably improved in quality. The retentivity diminishes and the coercive force increases with increase of Ni until the non-magnetic condition is reached at 25–30 per cent. Ni. Thereafter the retentivity is again evident and the coercive force is small. The coercive forces tend to diminish with each succeeding heat treatment. The alloy with least hysteresis is the 50 per cent. Ni, which has only 50 per cent. of the loss for pure iron, but it is not suited for use in practice. Increase of Ni raises the electric resistance to a maximum with about 30 per cent. Ni, when the resistance is about 6·8 times that for pure iron. Further increase to 100 per cent. results in a continued diminution in the resistance. It is suggested that the max. resistance may occur with 34 per cent. Ni, corresponding to the compound Fe_3Ni. A. D. R.

447. *Magnetic Storm, September* 25, 1909. **W. J. S. Lockyer.** (Roy. Astronom. Soc., M.N. 70. pp. 12–18, Nov. 12, 1909.)—Description of a series of spectroheliograms showing the rapid changes of flocculic material in the neighbourhood of a group of sun-spots at the time of the great magnetic storm. In one case the calcium cloud is shown to be of such extent as to entirely obliterate the spot umbra. In discussing the possibility of association between the spot activity and the magnetic storm, it is stated that the max. intensity of the spot occurred at Sept. 24, 10 a.m., and of the magnetic storm at Sept. 25, 4.30 p.m., thus indicating a lag of about 30·5 hours. In the case of a somewhat similar phenomenon observed by G. E. Hale, on July 15, 1892, the lag of the magnetic storm was about 25 hours. **J. E. Burbank.** (Terrestrial Magnetism, 14. pp. 177–181, Dec., 1909.)—The first indications of this great storm appeared on the magnetograms obtained at the Magnetic Observatory, at Cheltenham, Maryland, on Sept. 25, about 8h. 27m. a.m. (Eastern time), and continued as a moderate disturbance until 6h. 39m., when the principal portion of the disturbance began, and lasted until about 16h. During a considerable time the scale was unreadable, but an actual observed change of magnetic declination showed a difference of about 5° in 14 minutes of time. In horizontal intensity the estimated value at 8h. 05m. was 2000 γ below normal, and an eye reading at 13h. 19m. gave a value of 465 γ above normal, showing a range of about 2500 γ. **W. v. Kesslitz.** (Meteorolog. Zeitschr. 26. pp. 512–513, Nov., 1909.)—Details of the magnetic oscillations during the progress of the great magnetic storm of Sept. 25, 1909, observed at Pola. A copy of the declination chart is given. C. P. B.

448. *Magnetic Deviability of Solar Corpuscular Rays.* **K. Birkeland.** (Comptes Rendus, 150. pp. 246–248, Jan. 24, 1910.)—From a study of the lag of the magnetic storm after the passage of a large spot across the sun's central meridian, Ricco has deduced a velocity of 900 to 1000 km. per sec. for the supposed rays emitted from the sun and transmitted to the earth. From this, Birkeland concludes that the sun must have a magnetic moment about 100 times greater than that of the earth to produce a magnetic deviation of the rays equivalent to the lag of 40–50 hours. He also suggests that, with similar directions of rotation, the magnetism of the sun must be opposite to that of the planets, but that this general magnetism is independent to some extent of the strong local magnetism evidenced in the spot vapours. C. P. B.

ELECTRO-PHYSIOLOGY AND ELECTRO-THERAPEUTICS.

449. *Behaviour of Organic Bodies with respect to the* α-, β-, *and* γ-*Rays of Radium and Röntgen Rays.* **Guilleminot.** (Comptes Rendus, 150. pp. 332–335, Feb. 7, 1910.)—If Röntgen rays of different qualities act upon the tissues the biochemical effects produced appear to be a function of the quantities absorbed per unit of thickness or of mass. From experiments carried out with paraffin and Al (the former of which approaches in behaviour the organic tissues), it is concluded that paraffin has a remarkable power of absorption for the α- and β-rays of Ra as compared with Al, and the rate of millimetric absorption is considerable for the first layers traversed. From this may be explained the very powerful action due to radiation from Ra, even in small quantities, upon the first epidermic layers, and the superficial lesions when it is not filtered. A. E. G.

REFERENCES.

450. *Variation with Velocity of e/m for Kathode Rays.* **C. A. Proctor.** (Phys. Rev. 30. pp. 53–61, Jan., 1910.)—Measurements were made of the ratio *e/m* by observations of the magnetic and electric deflections of the rays in a kathode tube. The results cover a range of velocities only from twelve to forty-three hundredths of the velocity of light and are in closer agreement with the theory of Abraham than with that of Lorentz. J. J. S.

451. *High-pressure Spark-gap in Nitrogen.* **F. J. Jervis-Smith.** (Nature, 82. p. 9, Nov. 4, 1909.)—A brief note pointing out the advantages of a spark-gap operating in nitrogen under a pressure of 50 lbs. per sq. in. L. H. W.

452. *Alternating-current Spark Potentials.* **A. Russell.** (Phil. Mag. 19. pp. 203–205, Jan., 1910.)—Russell here criticises the statements of Kowalski and Rappel [see Abstracts Nos. 1593, 2120 (1909)] upon his assumption regarding spark potentials. A. E. G.

453. *Heating of Conductors by the Electric Current.* **L. Roy.** (Journ. de Physique, 8. pp. 476–493, July, 1909.)—[See Abstract No. 942B (1908).]

454. *Report on Practical Standards for Electrical Measurements.* (Brit. Assoc. Report, pp. 31–55, 1908. Report of B.A. Committee.)—The full Report corresponding to Abstract No. 1681 (1908).

455. *Regulation of Potential Transformers and the Magnetising Current.* **M. G. Lloyd** and **P. G. Agnew.** (Bureau of Standards, Bull. 6. pp. 273–280, Nov., 1909.)—The full paper corresponding to Abstract No. 873B (1909).

456. *Determination of the Constants of Instrument Transformers.* **P. G. Agnew** and **T. T. Fitch.** (Bureau of Standards, Bull. 6. pp. 281–299, Nov., 1909.)—The full paper corresponding to Abstract No. 1141B (1909).

457. *Effective Resistance and Inductance of a Helical Coil.* **J. W. Nicholson.** (Phil. Mag. 19. pp. 77–91, Jan., 1910. Paper read before the Physical Soc., Nov. 26, 1909.)—The problem of the resistance and inductance of a thin wire wound on a cylinder so as to form a helix having an appreciable pitch is discussed. The coil is considered to be so long that the end effects are neglected. A system of helical co-ordinates is chosen which is particularly convenient in problems where surface conditions have to be satisfied at the boundaries of such wires. Approximate solutions are obtained in algebraic form by means of asymptotic formulæ developed by Russell. The numerical values can also be readily found by means of the tables computed by Savidge. A. R.

458. *Calculation of Resistance of Alloys free from Solid Solutions.* **K. Lichtenecker.** (Phys. Zeitschr. 10. pp. 1005–1008, Dec. 15, 1909.)—Extending the work of Guertler [see Abstracts Nos. 1186 (1907) and 980 (1908)] the author deduces a simple formula for the calculation of the electrical resistance of alloys of metals forming no solid solutions. Examples are given showing that the calculated values agree with observed values within the limits of experimental error. F. C. A. H. L.

459. *Mobility of Electrons.* **L. Silberstein.** (Ann. d. Physik, 31. 2. pp. 436–442, Jan. 28, 1910.) *Compatibility Conditions.* **A. Sommerfeld.** (Ibid. pp. 443–444, Jan. 28, 1910.)—A highly analytical paper by the first author with remarks upon it by the second. [See also Abstracts Nos. 1694 (1908), 706, and 1428 (1909).] E. H. B.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

460. *Absorption of Uranium X by Charcoal.* **A. Ritzel.** (Zeitschr. Phys. Chem. 67. 6. pp. 724–761, Oct. 12, 1909.)—The author has followed quantitatively the adsorption of UrX by purified charcoal, the activity of the UrX being measured by determining the β-activity by means of a β-electroscope, the α-rays entering the latter being absorbed by paper. The measurement of the activity of a solution containing UrX presents difficulties owing to absorption of the β-rays by water, so that a definite portion of the solution was evaporated and the activity of the dry, powdered uranium nitrate determined by means of the electroscope; this method gives results accurate to about 0·5 per cent. Charcoal takes up UrX from uranium nitrate solution at first very rapidly and subsequently more and more slowly until after about ten days, equilibrium is reached represented by the equation $C_L = \text{const.} \times C_K$, where C_L and C_K are the concentrations of the UrX in the solution and charcoal respectively. The results obtained are explainable on the assumption that the UrX is first adsorbed by the charcoal and later diffuses into it, that is, is absorbed. The value of the ratio $C_L : C_K$ diminishes to zero as the concentration of the uranium nitrate solution falls to 0. Further, the value of $C_L : C_K$ varies with different specimens of uranium nitrate if these have not been previously shaken once with charcoal, owing to the fact that fresh uranium nitrate contains other radio-elements besides UrX. When the uranium nitrate solution contains a small quantity of thorium, the UrX is, for the most part, not adsorbed. The distribution of the UrX between charcoal and a solution containing no Ur has also been studied. In the case of hydrochloric, nitric, or sulphuric acid, equilibrium is attained after a few hours and is represented by the equation $C_L = \text{const.} (C_K - K)$. UrX is also absorbed by sodium hydroxide solution, but not by water, salt solutions, or ether. T. H. P.

461. *Coefficient of Diffusion of Radium Emanation in Air.* **L. Chaumont.** (Le Radium, 6. pp. 106–108, April, 1909.)—Very different values for the atomic weight of RaEm have been obtained; thus Bumstead and Wheeler [Abstract No. 1069 (1904)] found it to be about 180, Makower [Abstract No. 1066 (1905)] obtained values for it between 88·5 and 99, and Perkins [Abstract No. 1217 (1908)] gives for it the number 235. It is now found that the coefficient of diffusion of RaEm in dry air at 0° C. and 760 mm. pressure is 0·1015. Assuming that the product of the coefficient of diffusion of a gas, and the square root of its molecular weight is a constant and equal to 0·90, then the corresponding molecular weight of RaEm is 80. Although the relation $D\sqrt{M} = \text{a const.}$ is only approximately true, other considerations lead to the conclusion that the value of the molecular weight of RaEm lies between 75 and 100. A. E. G.

462. *Action of α-Rays on Glass.* **E. Rutherford.** (Manchester Lit. and Phil. Soc., Mem. 54. 1. p. 1, 1909–1910. Phil. Mag. 19. pp. 192–194, Jan., 1910.)—It has been shown by Joly that the pleochroic halos observed in mica are to be ascribed to the action of α-rays emitted by small inclusions of radioactive material. The radius of the halo (about 0·04 mm.) indicates that the effect is due in large part to the rays from Ra. A large quantity of RaEm is enclosed in a fine capillary tube of soda glass. After the emanation has decayed, the inner wall of the capillary is seen under the microscope to be surrounded by an area of distinct colouration extending about 0·04 mm. from the walls. The outer boundary of the coloured region is sharply defined and the depth of the colouration is equivalent to the max. distance of the most penetrating α-rays from the active matter, thus confirming Joly's explanation of halos. A. E. G.

463. *Reduction of Weighings to a Vacuum and its Application to Atomic Weight Determinations.* **P. A. Guye** and **N. Zachariades.** (Comptes Rendus, 149. pp. 593–594, Oct. 11, 1909.)—The calculation of the weight of a substance *in vacuo* from its weight in air, though possibly sufficiently exact for cast metals, gives erroneous results when applied to powdered substances, which condense considerable quantities of gases or vapours on their surfaces. The authors have examined a series of 26 salts which have been employed in the laboratory at Harvard for the determination of atomic weights. As a result it is concluded that, when atomic weights are based on the calculation of the weights of powdered substances *in vacuo*, it is useless to ascribe an accuracy of more than about 1 part in 10,000 to the values obtained. T. H. P.

464. *Chemical Reactions in Gases at High Pressures: Decomposition of Nitric Oxide and Formation of Nitrosyl Chloride.* **E. Briner** and **A. Wroczynski.** (Comptes Rendus, 149. pp. 1372–1374, Dec. 27, 1909.)—Continuing their previous investigations [see Abstract No. 1466 (1909)], the authors find that when a mixture of 8 vols. NO and 1 vol. HCl is subjected to 800 atmos. pressure at the ordinary temperature, nitrosyl chloride is gradually formed. Further, under the same conditions, nitric oxide yields continually increasing quantities of nitrous oxide, the decomposition occurring according to the equation: $3NO = N_2O_3 + N$. This decomposition evidently precedes the formation of nitrosyl chloride from nitric oxide and hydrogen chloride, the second stage being represented, thus: $N_2O_3 + 2HCl = 2NOCl + H_2O$.

T. H. P.

465. *Laws of Electrode Losses in Electric Furnaces.* **C. Hering.** (Electrochem. Ind., N.Y. 7. pp. 442–448, Oct., 1909. Elect. Rev. and West. Electn. 55. pp. 993–994, Nov. 20, and pp. 1082–1084, Dec. 4, 1909. Abstract.)—Assuming that the electrodes have a uniform cross-section throughout their whole length, that no heat leaves the electrode to the furnace walls nor enters it from them, and that the temperature variation of the conductivities is approximately a straight line proportion, then under these assumed conditions, the following are the laws of electrode losses: (*a*) The combined loss through the cold end of an electrode is equivalent to the sum of the loss by heat conduction alone (when there is no current) and half the C^2R loss. (*b*) This combined loss will be least when the loss by heat conduction alone is made equal to half the C^2R loss. (*c*) This minimum loss is dependent only on the material, current and temperature, but not on the absolute dimensions; it merely fixes the relation of the cross-section to the length, but leaves a choice of either; hence (*d*) for economy of electrode material, the length should be made as short as practical considerations permit. (*e*) For each material there is a definite minimum loss of electrode voltage which depends only on the temperature, and is independent of the dimensions or the normal current for which the furnace is designed; hence (*f*) the best possible electrode efficiency for any material may be determined from the total voltage due to the material and the temperature, and is independent of the dimensions. (*g*) The heat gradient of the combined flow is equal to the sum of the heat gradients of the individual flows. The paper deals with the above laws in some detail and shows their practical bearing. C. O. B.

466. *Electrode Efficiency of Furnaces.* **C. Hering.** (Electrochem. Ind., N.Y. 7. pp. 473–474, Nov., 1909.)—If the voltage between the inside or hot ends of the two electrodes of a furnace be divided by that between the outside or cold ends, a figure is obtained for which the writer has suggested the name, electrode efficiency, as it is a true measure of the efficiency of the furnace so far as the loss of power in the electrodes is concerned. The author has shown previously [see preceding Abstract], that for any given electrode material, there exists a curious and interesting minimum drop in voltage, below which it is not possible to go without again increasing the total loss. This voltage the author suggested naming the electrode voltage; it has a different value for different materials and is independent of the length or cross-section of the electrode or the current passing through it. It is, however, dependent on the temperature drop in the electrode and hence, as a constant it must be understood to be for 1 deg. of temperature drop. It increases as the square root of the temperature drop, and varies as the square root of the quotient of the heat conductivity, divided by the electrical conductivity. For 1 deg. temperature drop, it is therefore equal to, in volts: $e = A\sqrt{(k/K)}$, in which k is the thermal conductivity, K the electrical conductivity and A a constant depending on the units used. As the electric resistivity r is more commonly used than the conductivity, this formula is more convenient in the form, $e = A\sqrt{(rk)}$. An example given for graphite shows $e = 0{\cdot}0231$ volt for 1 deg. C. drop in temperature; therefore for a temperature drop of 1600 deg. C. the voltage drop will be $40 \times 0{\cdot}0231 = 0{\cdot}92$ volt. C. O. B.

467. *Emission of Gases by Heated Metals.* **G. Belloc.** (Comptes Rendus, 149. pp. 672–673, Oct. 26, 1909.)—The emission commences about 150–200°, but is only slight until a temperature of about 400° is reached. A sample heated to 780° gave 8·30 cm.^{3} at the first heating, 8·25 at the second (8 days later), and a total of 9·55 cm.^{3} in seven heatings. L. H. W.

468. *Copper-Zinc Alloys.* **T. Turner** and **M. T. Murray.** (Metal Industry, 1. pp. 196–197, Dec. 24, 1909. Abstract of paper read before the Institute of Metals, Manchester, Oct. 15, 1909.)—This paper contains the results of the study of the volume-changes of brass during solidification, of which the following is a summary: (1) Of the common metals in the pure state, a few (such as Sb, Zn, and Al) expand on solidification; others (including Pb, Sn, Cu, and Bi) do not expand on solidification. All these metals, after total solidification, contract in the mould at a uniformly decreasing rate until they reach the temperature of the air. (2) Of the brasses, where a simple solid solution exists, the curve of maximum expansion follows the "solidus," when the "liquidus" curve is taken as the base line; minima on the expansion curve occur at 100, 60, and 40 per cent. Cu; maxima appear at 80, 50, and 14·76 per cent. Cu. (3) The total shrinkage of the brasses shows minima at about 72, 58, and 20 per cent. Cu, while maxima occur at 65 and 40 per cent. Cu. (4) The hardness-curve of the brasses (by both scleroscope and Brinell methods) gives maxima at 78–80, 55, 40, and 9 per cent. Cu; minima

occur at 100, 70, 52, 15, and 0 per cent. Cu. (5) The authors consider that a compound exists at 40 per cent. Cu, confirming Guertler's view. This alloy is considered by Shepherd to be a solid solution. The existence of the other numerous compounds set forth by Tafel has not been confirmed by these experiments. A table showing the hardness-numbers of the brasses is included. C. O. B.

469. *Transformation-points of Aluminium-Copper Alloys.* **M. Barrée.** (Comptes Rendus, 149. pp. 678–681, Oct. 26, 1909.)—A study of the variation of electrical resistance with temperature, of four Al-Cu alloys, containing 8·7 to 12·95 per cent. Al, and up to 1·15 per cent. Fe, shows the existence of transformation-points at about 200°, 500°, and 750° C. The two latter points agree with observations of Guillet, but the change at 200° has not hitherto been recorded. The resistance has been measured with both rising and falling temperatures, and the variations are perfectly reversible, except in the neighbourhood of the transformation-points, these being lower during cooling than during the heating process. Successive heatings do not alter the transformation-points. [See also Abstract No. 434 (1910).] W. H. Si.

470. *Cobalt Alloys.* **F. Ducelliez.** (Comptes Rendus, 150. pp. 98–101, Jan. 10, 1910).—The author has made observations of the e.m.f.'s generated by the systems: $Co—nCoSO_4—CoM^x$, and $M—nCoSO_4—CoM^x$, where M represents Sn, Sb, Bi, Pb, or Cu, and plots the results in the form of e.m.f.-concentration curves. The curve for the Co-Sn series shows a marked inflection at 66·76 per cent. Sn, indicating the existence of the compound CoSn. The Co-Sb curve indicates the existence of two compounds—CoSb and $CoSb_2$. Cobalt-bismuth alloys form two layers, and the e.m.f. of most of the alloys is very small. The curve shows that while Co separates in practically the pure state, Bi retains about 5 per cent. Co in solution. Cobalt-lead alloys are exactly analogous to the Co-Bi alloys. The Co-Cu curve gives no indication of the existence of compounds, but proves the existence of several solid solutions. F. C. A. H. L.

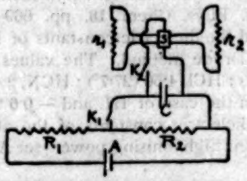
471. *Cementation of Iron with Solid Carbon.* **G. Charpy** and **S. Bonnerot.** (Comptes Rendus, 150. pp. 173–175, Jan. 17, 1910).—Soft Martin steel heated with pure carbon (from sugar, graphite, or diamond) to 1,000° C. *in vacuo* for some hours, after first separately exhausting the steel and carbon *in vacuo* at 1000° C., does not show any absorption of carbon when microscopically examined, and it is concluded that cementation of iron does not take place with solid carbon on its surface in the absence of any gaseous medium. The difficulty of making the contact of the steel and carbon sufficiently close renders further experiments necessary to prove whether diffusion of carbon into steel, when embedded in its interior, takes place with or without the presence of occluded gas. W. H. Si.

472. *Heat Treatment of Spring Steel.* **L. H. Fry.** (Mech. Eng. 24. pp. 826–828, Dec. 31, 1909. Paper read at Congress of the Internat. Soc. for Testing Materials, Copenhagen.)—Contains an account of a series of tests made to determine the effect of certain heat treatments on the transverse elastic limit and on the modulus of elasticity of the steel commonly used for locomotive-carrying springs. The points under investigation were: (1) the effect of annealing, (2) the comparative effect of quenching in water and in oil, (3) the effect of reheating the steel to various temperatures after complete cooling in water or in oil. The steel experimented upon was basic open-hearth spring steel, containing 1·01 per cent. carbon. The following temperatures were used as having been proved to be the most desirable: For annealing 1400° F., for quenching in oil 1450° F., for quenching in water 1425° F. For annealing, the test-pieces were plunged in a lead bath, the bath heated to 1400° F., kept at that temperature for 2 hours, and then allowed to cool off naturally. For hardening, the test-pieces were brought to the temperatures indicated above and then quenched: (1) in oil at 80° F., (2) in pure running water at 60° F. For drawing the temper up to 600° F. the test-pieces were placed in an oil bath; for drawing the temper above 600° F. a lead bath was used. The results of the tests are shown in a table in the original. The following points are illustrated by the tests: The higher the temper is drawn after hardening, the lower the elastic limit falls; also a lower elastic limit is obtained with test-pieces quenched in the bath which has the lower heat conductivity, viz., oil. The tests show that the elastic limit of 1 per cent. carbon steel can be made to vary from 78,500 up to 240,800 lbs. per sq. in. by changes in the heat treatment and that very small changes in the "drawing of the temper" are sufficient to affect the elastic limit of steel. C. O. B.

473. *Dielectric Constants of the Halogen Hydrides.* **O. C. Schaefer** and **H. Schlundt.** (Journ. Phys. Chem. 13. pp. 669–672, Dec., 1909.)—The authors have determined the dielectric constants of liquid or solid HI, HBr, HCl, and HCN by the Drude method. The values obtained are: HI, 2·90 (21·7°); HBr, 3·82 (24·7°); HCl, 4·60 (27·7°); HCN, 2·4 (−25°). The temperature-coefficient is zero in the case of HI, and −0·6 to −0·8 per cent. in the other cases. The low dielectric constants of the above substances are in marked contrast with their high ionising power [see Abstract No. 1780 (1907)]. A. F.

474. *Oxidation Potential of Manganese Dioxide.* **W. Haehnel.** (Zeitschr. Elektrochem. 15. pp. 834–842, Nov. 1, 1909. Physikal. Chem. Abt. des Chem. Univ.-Laborat., Breslau, Aug., 1909.)—The author attempts to determine the oxidation potential of MnO_2 by means of three lines of study: (1) Equilibrium between MnO_2, $Mn^{\cdot\cdot}$, J_2, J' (or Br_2, Br') in the presence of a sparingly soluble silver salt; (2) electrolytic decomposition of diluted solutions of manganese sulphate to which sulphuric acid is added, under deposition of MnO_2, the kathode being a copper spiral in copper sulphate; (3) reversal of the reaction $MnO_2 + 4HCl \longrightarrow Cl_2 + MnCl_2 + 2H_2O$ by passing chlorine gas into solution of manganous chloride, when MnO_2 is precipitated. The reactions are very complicated, and (1) and (3) in particular did not give concordant results. The potential of MnO_2 seems to lie between 1·3 and 1·4 volts. H. B.

475. *Some Laws Concerning Voltaic Cells.* **E. H. Landis.** (Frank. Inst., Journ. 168. pp. 399–420, Dec., 1909.)—The author draws attention to the conflicting opinions held by different authorities as to the identity of e.m.f. and p.d. Excepting processes not caused by the current, or in which a portion of energy disappears at part of a circuit and an equal portion of energy appears at the same part of the circuit, whenever energy not electrical appears or disappears at part of a circuit, work has been done *by* the current or *upon* the current, the work being measured by the energy which appears or disappears, and the change of potential by the work done per unit of electricity. Changes of potential caused by currents flowing against resistance involve a consumption of electrical energy, but are not e.m.f.'s, whereas changes of potential with a current flowing, arising from causes other than resistance, are termed e.m.f.'s whether a generation or consumption of electrical energy is involved. Changes of potential occurring when no current flows are also called e.m.f.'s. The Daniell cell is taken as a typical cell, and the processes occurring therein are examined, the change of potential taking place at the Cu-Zn junction being a controversial point which is still considered unsettled. From the net decrease of chemical energy of 25,050 cals., the e.m.f. of a Daniell cell is calculated as about 1·09 volts. When a current is flowing, the most accurate measurement of the e.m.f. of a cell is made by finding the product of the current and the resistance in the circuit outside the cell, and the best method is to measure the rise of potential e through the cell from the negative to the positive terminal when a known current is passing through it, and immediately after opening the circuit, before disturbing changes can occur, to measure the rise of potential E through the cell when no current is flowing. Then, denoting the current by I, if the e.m.f. of the cell with a current is equal to the e.m.f. found immediately upon the cessation of the current, $E - e$ is the fall of potential in the cell caused by resistance r, and $r = (E - e)/I$. Measurements made in this manner by Carhart and by Ayres showing some slight discrepancy, the author has experimented with a Daniell cell, using the arrangement shown in the Fig. where C is the Daniell cell, R_2 a resistance in which a current flows from the storage cell A, the current being maintained steady by keeping the temperature of A constant, and the sum of the resistances R_1 and R_2 in two boxes always equal to that of one of these with all the plugs removed. The current through R_1 and R_2 is measured before and after a series of measurements by balancing a Clark cell across R_2. The rise of potential in the cell is first measured before any current is taken from it, then a circuit is closed containing the cell and the box r_1 with a resistance of 15 ohms in it. When the cell has reached a constant state, rises of potential in the cell are measured the while the current is flowing, and immediately after opening the circuit momentarily at the key K_2; the rises of potential of the cell in the same state are measured immediately after momentarily disconnecting r_1 from the cell and connecting r_2 to the cell with resistances of 60 and 200 ohms successively. The resistance of the cell is found to vary from 15·49 to 15·68, which is regarded as a satisfactory confirmation of Ayres' results, the values of the resistance so obtained being slightly low, owing to the e.m.f. immediately on cessation of the current being smaller than the e.m.f. of the cell with the current. W. H. St.



476. *Investigation of Electrolysis by means of the Ultramicroscope.* **J. J. Kossonogow.** (Jurn. Russk. Fisik-Chimičesk. Obščestva, 41. 9. pp. 373–

894, 1909. Phys. Zeitschr. 10. pp. 976–986, Dec. 15, 1909. Physikal. Laborat. d. St. Wladimir Univ., Kiew, Jan., 1909.)—The apparatus employed by the author consists of an ultramicroscope directed to that layer of an electrolyte through which passes the narrowest part of the light-cone, the light previously traversing a solution of ammonium chloride, which acts as a heat-filter. The ends of the electrodes, the remaining parts of which are insulated, are situate in the same layer. Observation of the liquid by this arrangement shows here and there in the field of view small bright particles almost always in a condition of vibratory motion. With a dilute copper sulphate solution through which a current is passed by means of copper electrodes, these bright points move towards the electrodes apparently in the direction of the current; some of the particles midway between the electrodes exhibit, however, no motion in any definite direction. Similar phenomena are observed with silver nitrate solution containing silver electrodes, but with non-electrolytes, such as benzene, no such bright points or movements are to be seen. Approach of an electromagnet to the electrolytic cell is accompanied by bending of the paths of the bright points in a direction in accord with Ampère's rule. Measurement of the rates of motion of these bright particles by means of an eyepiece micrometer shows that the velocities for a potential gradient of 1 volt per cm. are of the same order of magnitude as the velocities of the ions calculated by Kohlrausch from the transport-numbers and conductivities of electrolytes. When copper sulphate or silver nitrate solution is subjected to the action of an alternating current, the bright points hover in the neighbourhood of the electrodes, approaching and retreating and forming aggregates which move after the manner of bees. With a direct current, when the p.d. applied exceeds a certain "critical" value, enormous numbers of fine, bright particles—up to 10 per 0·001 mm.^{3}—appear at the kathode one or two seconds after the circuit is closed. These particles form a thin, dense layer parallel to the surface of the electrode and distant from it 0·05–0·08 mm. In this layer the particles are in a state of intense vibratory motion, but in the space between the layer and the electrode not a single bright point is to be seen; this empty space persists when the p.d. exceeds the critical value and is termed by the author "kathode dark space." Experiments with a N/100-silver nitrate solution show that the magnitude of the "critical" p.d. is independent of the dimensions of the free electrode surface. With silver electrodes in distilled water, a layer of bright particles is also formed when the p.d. has a certain "critical" value (0·986–1·021 volts), but in this case it is formed adjacent to the anode. With colloidal silver solution, a similar layer is formed, the "critical" p.d. being about 1 volt. If, when distilled water is used, the p.d. exceeds the "critical" value, two dense layers of bright points are observed, one at the anode, and the other in the liquid dividing the distance between anode and kathode in the ratio 6 : 11; from this intermediate layer the points appear to move towards both electrodes. This second layer is formed with electrodes of Cu, Bi, Zn, Cd, and Pb in distilled water, and in all these cases its position relative to the two electrodes is the same; with lead, more exact measurements gave the ratio of its distances from the two electrodes as 11 : 21, which is in very close agreement with the value, 18 : 33, determined by Kohlrausch for the relation between the velocities of the hydroxyl and hydrogen ions. The author is of opinion that the vibrating particles undoubtedly pass from the kathode layer across the dark space to the kathode, but that they first give up the charges carried by them and cease to be visible. During the electrolysis of a N/100-copper sulphate solution, it was observed that the gradual increase of the kathode conditioned a corresponding displacement of the kathode layer of bright points and of the dark space. In some cases the boundary layer of the kathode assumes regular ornamental shapes, and here, too, the kathodic layer of points and the dark space remain accurately parallel to it. The author concludes that there must be some intimate connection between the bright points and the carriers of electricity in an electrolyte, and suggests that the characteristic phenomena observed in an electrolyte when the p.d. equals the decomposition potential afford a ready means of determining this potential. T. H. P.

477. *Electrolysis with Alternating Currents in a Magnetic Field.* **F. Piola.** (Atti dell' Assoc. Elettr. Ital. 13. pp. 423–426, Sept.–Oct., 1909.)—The author describes electrolysis of water acidulated with sulphuric acid with an alternating current in a magnetic field, (1) with two Pt electrodes, and (2) with one of the electrodes of Cu. In both cases two separate streams of oxygen and hydrogen escape from the electrode, in a plane normal to the magnetic field, and diagrams are given showing the paths of the bubbles. The splitting up into two streams is not due to difference in sign of the magnetic susceptibility of the hydrogen and oxygen with respect to that of the water, since it ceases immediately the current is interrupted. The application of the principle not only to electrolysis in the laboratory, but in industry, is pointed out.

W. H. Sl.

478. *Electrolytic Oxidation of Ammonium Carbonate.* **F. Fichter** and **H. Kappeler.** (Zeitschr. Elektrochem. 15. pp. 937–948, Dec. 1, 1909.)—The authors discuss the literature on the subject and describe experiments made with Pt electrodes both in open cells and in Wehrlin's electrolyser. The chief products of the electrolysis of aqueous solutions of ammonium carbonate at the anode are ammonium nitrate and oxygen; the authors agree in general with Brochet and Boiteau, but did not observe the evolution of nitrogen. The yield of nitrate depends chiefly on the hydroxyl ions; the solution should not be acid, nor contain caustic soda, nor be diluted below 2 gm.-equivalents per litre. With a current density at the anode of from 0·4 to 0·6 amp./cm.^{2}, a temperature of 50° or 60° C., and a ratio of $\frac{1}{2}CO_3'' : NH_4^{\cdot} = 0{\cdot}55$, the yield of ammonium nitrate may be raised above 80 to 97 per cent. Solutions of ammonium tetraborate answer as well as carbonate solutions. H. B.

479. *Preparation of Colloidal Solutions of Selenium.* **A. Pochettino.** (Accad. Lincei, Atti, 18. pp. 544–551, Dec. 5, 1909.)—Adopting Müller and Nowakowski's method [Abstract No. 209 (1906)] and including in the circuit a Siemens-Halske milli-ammeter, it is found that contemporaneously with the production of a red colouration around the kathode, the intensity of current increases from the moment of closing the circuit. It is reduced by agitation of the liquid in the cell, but again rises immediately agitation ceases, tending to a limit at ten times its initial value. With an e.m.f. of less than 1·8 volts, colloidal Se is only produced after prolonged passage of the current. No trace of selenious acid could be detected. An e.m.f. of 48 volts and a mean current intensity of 7 milliamps., yields in 5 hours a solution containing about 24 centigrammes Se per litre, which when concentrated on a water-bath precipitates part of the Se in a black, vitreous state; on dialysis red, soluble, pulverulent Se is left on the membrane. Allowed to stand for about 24 hours a very thin, strongly adherent deposit of Se is precipitated on the sides of the containing vessel, which when detached has a blue colour by transmitted, and

a red colour by reflected light. The passage of an electric current at 40 volts through a colloidal solution of Se prepared by this method is accompanied by (1) collection of red soluble Se around the anode, (2) increase in intensity of the current, (3) deposition of part of the Se in the red state on the bottom of the vessel, and (4) gradual loss of red colour by the solution, which slowly becomes blue by transmitted light. On separating the anode from the kathode by a porous septum, the resistances of the two liquids in the anode and kathode chambers are equal, and approximately 50,000 ohms, when the electrodes are first immersed, but after 10 min. without again closing the circuit, the resistance in the kathode chamber is 14,000 ohms, and after 15 min. 18,000 ohms, that in the anode chamber remaining at 50,000 ohms; after an hour, they became 45,000 and 7800 ohms respectively. Immediately on closing the circuit the resistance is considerably diminished in both chambers, after 1 min. that in the anode chamber being 44,000 and that in the kathode chamber 7700; after 20 min. 14,200 and 1180 ohms; and after 1 hour, 8100 and 697 ohms respectively. Light does not appear to have any influence on the electrical resistance of these colloidal solutions of Se, and their internal viscosity is approximately the same as that of distilled water.

W. H. St.

480. *Electrolytic Determination of Chlorine in Hydrochloric Acid with the Use of the Silver Anode.* **F. A. Gooch** and **H. L. Read.** (Amer. Journ. Sci. 28. pp. 544–552, Dec., 1909.)—The authors show that the electrolytic determination of the chlorine in hydrochloric acid, using Hildebrand's method with a silver anode, is by no means an exact process. The bad results are due to the fact that the electrolysis of the HCl does not consist simply of the liberation of hydrogen at the kathode, and fixation of Cl at the anode; these effects are supplemented to a greater or lesser extent by the fixation of oxygen as well as Cl, and by the production of oxygen compounds of chlorine, as, for example, hypochlorous acid, with the consequent solution of Ag from the anode, and its more or less complete transfer to the kathode. T. S. P.

481. *Rapid Electro-analysis of Tin.* **B. Pásztor.** (Elektrochem. Zeitschr. 16. pp. 281–285, Jan., 1910.)—The material used was the double salt of stannic chloride and ammonium chloride. In the first set of experiments a cylindrical gauze kathode and a rotating spatula-shaped anode, both of Pt, were used; the kathode was coppered before the tin was deposited. Electrolytes containing oxalic acid were not satisfactory, owing to the precipitation of stannic acid, but excellent results were obtained when the oxalic acid was replaced by tartaric acid. 120 c.cm. of electrolyte were used containing from 0·2 to 0·4 gm. of tin in the form of the stannic double salt, 6 gm. tartaric acid, 1 gm. hydroxylamine sulphate, and 2 gm. of ammonium acetate. At a temperature of 80°, with a current density of 8 amps./$dm.^2$, and 600 revs. per min. of the anode, 0·1921 gm. tin could be quantitatively deposited in 80 min., and twice that quantity in 85 min. When the ordinary gauze kathode was replaced by a double-walled gauze kathode, the walls being 1 mm. apart, the current density could be raised to 12 amps./$dm.^2$, and the deposition of 0·1949 gm. tin was then complete in 25 min. In the ordinary analytical processes tin is precipitated as the sulphide. In order to determine the tin electrolytically, the sulphide is dissolved in a hot solution of ammonium chloride in concentrated HCl and the solution neutralised with ammonia. Tartaric acid, hydroxylamine sulphate, and ammonium acetate are then added as above, and the solution electrolysed; the results are quantitative. Tin can also be determined in the stannic ammonium chloride solution in the presence of formic acid. 120 c.cm. of electrolyte are used, containing 5 gm. of formic acid, and about 0·2 gm. of tin. Temperature is 70°, and the current density 8 or 12 amps./dm.^{2} according to the kathode used. The deposition is complete in 25 min. T. S. P.

REFERENCES.

482. *Apparatus for Determination of Transport Numbers.* **A. Findlay.** (Chem. News, 100. p. 185, Oct. 15, 1909.)

483. *New Proof of the Existence of Molecules.* III. **T. Svedberg.** (Zeitschr. Phys. Chem. 67. 2. pp. 249–256, July 23, 1909. Chem. Univ. Lab., Upsala, April, 1909.)—Data are given in reference to the absorption of light by colloidal gold, prepared by Zsigmondy's phosphorus method and also by means of hydrazine hydrochloride. [See Abstracts Nos. 1769 (1909), 189 (1910)]. T. M. L.

484. *Metallographic Observations in Vacuo at High Temperatures.* **P. Oberhoffer.** (Metallurgie, 6. pp. 554–566, Sept. 8, 1909. Zeitschr. Elektrochem. 15. pp. 634–646, Sept. 1, 1909. Paper read before the Deutsch. Bunsen-Gesell., Aachen.)—Describes an apparatus suitable for maintaining the specimen at a high temperature in such a way that microscopical observation is easy at all times. Results of an investigation are appended. L. H. W.

485. *Cooling Curves and New Apparatus for their Autographic Registration.* **E. F. Northrup.** (Amer. Electrochem. Soc., Trans. 15. pp. 331–359, 1909.)—The author employs a differential galvanometer and two resistance thermometers in place of a thermo-couple to take the temperature-time curve. L. H. W.

486. *Photomicrographs of Copper taken during the Refining Process.* **W. Stahl.** (Metallurgie, 6. pp. 609–610, Oct. 8, 1909.)

487. *The Alloys of Iron.* **P. Oberhoffer.** (Metallurgie, 6. pp. 612–618, Oct. 8, 1909.)—A general discussion in the light of present knowledge.

488. *Development of the Equilibrium Diagram of the Iron-Carbon Alloys.* **F. Wüst.** (Zeitschr. Elektrochem. 15. pp. 565–583, Aug. 15, 1909. Paper read before the Deutsch. Bunsen-Gesell.)

489. *Effect of Impurities on the Equilibrium Diagram of the Iron-Carbon Alloys.* **P. Goerens.** (Metallurgie, 6. pp. 531–536, Aug. 22, and pp. 537–549, Sept. 8, 1909. Paper read before the Deutsch. Bunsen-Gesell., Aachen. Zeitschr. Elektrochem. 15. pp. 617–634, Sept. 1, 1909.)

490. *Diffusion and Kinetic Theory of Solutions.* **G. Thovert.** (Comptes Rendus, 150. pp. 270–272, Jan. 31, 1910.)—The author has already shown that the diffusion coefficient of non-electrolytic substances dissolved in aqueous solvents varies inversely as the square root of the molecular mass. He now finds that the results are less simple where methyl alcohol is the solvent, so that the relation $D\sqrt{M}=\text{const.}$ is not quite general, though—according to the author—easy to interpret by the kinetic theory of diffusion. D. H. J.

491. *The Leclanché Cell.* **E. Friederich.** (Elektrochem. Zeitschr. 16. pp. 219–223, Nov.; 252–256, Dec., 1909, and pp. 287–292, Jan., 1910.)—The author discusses the construction, performance, and electrochemistry of the cell, on open and closed circuit, on the basis of experiments of his own and general experience, with special regard to the influence of the kind and grain of carbon, of the manganese dioxide and of the electrolyte. H. B.